Get the Details on Our Newest Podcast, "Eclectic Tech." Page 67

QST
DIGITAL EDITION

ARRL The national association for AMATEUR RADIO®
March 2020 www.arrl.org
DEVOTED ENTIRELY TO AMATEUR RADIO

Make Your Own Open-Wire Line

QST Reviews

Xiegu G90 HF Transceiver
SOTABEAMS
Wolfware Audio Processor
Inexpensive Antenna System Tuning Indicators

The radio... YAESU

FTDX101 TECHNICAL HIGHLIGHT - #4

3DSS (3-Dimensional Spectrum Stream)

Displays the constantly changing band conditions in 3D
Instantly observe changes in the strength of the signals

- *Display up to 25 seconds of previous band conditions in real time*
- *Simultaneously view output from both Narrow band SDR and Direct Sampling SDR on the display*
- *Versatile scope and multi-color SDR display configuration enables clear and easy viewed presentation provided by 7" TFT Color touch panel display*

HF/50MHz TRANSCEIVER
FTDX101MP 200W

HF/50MHz TRANSCEIVER
FTDX101D 100W

* Microphone M-1: Optional

YAESU
The radio

YAESU USA
6125 Phyllis Drive, Cypress,
CA 90630 (714) 827-7600

For the latest Yaesu news, visit us on the Internet: **http://www.yaesu.com**

C4FM/FM 144/430 MHz
Dual Band 5W
Digital Transceiver

FT-70DR

《 700 mW Loud and Clear audio,
Commercial Grade Specifications 》

WIRES-X
Portable Digital Node
Available

C4FM/FM 144/430 MHz
Dual Band 5 W
Digital Transceiver

FT3DR

《 Improved 66 ch
GPS receiver included 》

WIRES-X
Portable Digital Node
Available

C4FM/FM 144/430 MHz
Dual Band 5 W
Digital Transceiver

FT2DR

《 Improved 66 ch
GPS receiver included 》

System Fusion II

C4FM Digital
Pursuing Advanced Communications

WIRES-X
Portable Digital Node
Available

C4FM/FM
144/430 MHz Dual Band 50 W
Digital Transceiver

FTM-100DR

《 Improved 66 ch GPS receiver included 》

C4FM/FM 144/430 MHz
Dual Band Dual Receive Digital Repeater

DR-2X

C4FM/FM 144/430 MHz Dual Band 50 W
Digital Transceiver

FTM-7250DR

《 Heavy Duty 50 Watts High Power 》

WIRES-X
Portable Digital Node
Available

C4FM/FM
144/430 MHz Dual Band 50 W
Digital Transceiver

FTM-400XDR

《 Improved 66 ch GPS receiver included 》

C4FM/FM 144 MHz 65 W
Digital Transceiver

FTM-3200DR

《 Genuine 65 Watts High Power 》

CW/SSB/AM/FM/C4FM
HF/50/144/430 MHz Wide-Coverage
100 W All Mode Transceiver (144/430 MHz: 50 W)

FT-991 A

《 Real-Time Spectrum Scope included 》

C4FM/FM 430 MHz 55 W
Digital Transceiver

FTM-3207DR

《 Heavy Duty 55 Watts High Power 》

System Fusion II Supports All C4FM Portables and Mobiles

YAESU
The radio

YAESU USA
6125 Phyllis Drive, Cypress,
CA 90630 (714) 827-7600

For the latest Yaesu news, visit us on the Internet: **http://www.yaesu.com**

Cushcraft Antennas

R9

80-6 Meters! No Radials!

Cushcraft's world famous R8 now has a big brother!

Big Brother R9 now includes 75/80 Meters for local ragchewing and worldwide low band DX without radials!

It's omni-directional low angle radiation gives you exciting and easy DX on all 9 bands: 75/80, 40, 30, 20, 17, 15, 12, 10 and 6 Meters with low SWR. QSY instantly – no antenna tuner needed.

Use full 1500 Watts SSB/CW when the going gets tough to break through pileups and poor band conditions.

The R9 is super easy to assemble, installs just about anywhere, and its low profile blends inconspicuously into the background in urban and country settings alike.

Compact Footprint: Installs in an area about the size of a child's sandbox – no ground radials to bury with all RF-energized surfaces safely out of reach.

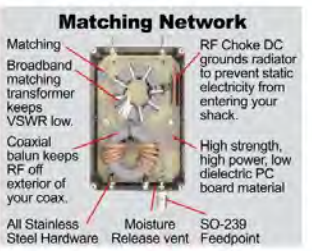
Rugged Construction: Thick fiberglass insulators, all stainless steel hardware and 6063 aircraft-aluminum tubing is double or triple walled at key stress points to handle anything Mother Nature can dish out.

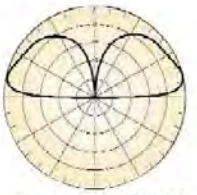
31.5 feet tall, 25 lbs. Mounting mast 1.25 to 2 inches. Wind surface area is 4 square feet.

R8, $599.95. Like R9 antenna but less 75/80 Meters.

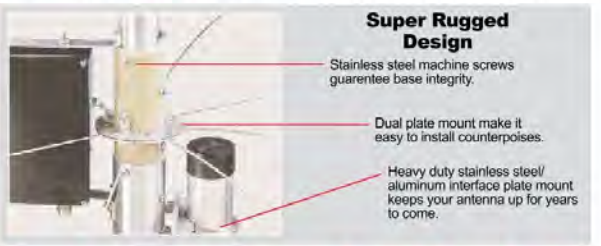
R-8TB, $99.95. Tilt-base lets you tilt your antenna up/down easily by yourself to work on.

R-8GK, $79.95. Three-point guy kit for high winds.





Omni-Directional
Low angle radiation gives incredible worldwide DX.

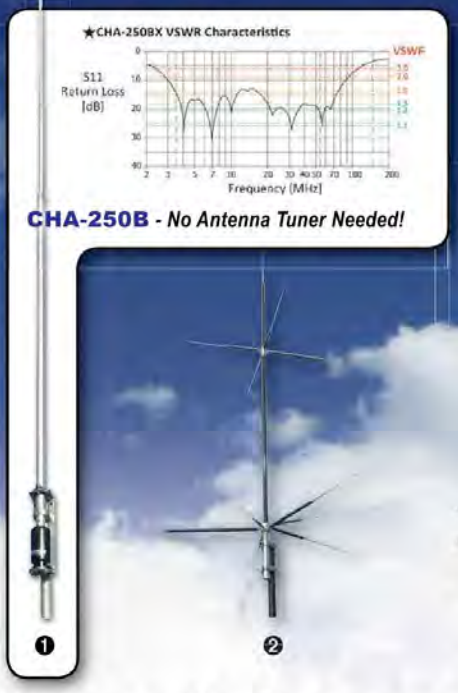


Cushcraft...Keeping You in Touch Around the Globe!

Cushcraft **Amateur Radio Antennas** 308 Industrial Pk Rd, Starkville, MS 39759 USA
Sales/Tech: (662) 323-9538 ■ **FAX:** (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.

C★MET®

Life is a JOURNEY. Enjoy the ride!



CHA-250B - *No Antenna Tuner Needed!*

Base Antennas

❶ C★MET CHA-250B BROADBAND 80M THROUGH 6M VERTICAL ANTENNA
A newly designed broadband vertical with NO GROUND RADIALS. EXTREMELY easy to assemble, requires no tuning or adjustments and VSWR is under 1.5:1 from 3.5-57MHz! • TX: 3.5MHz – 57MHz • RX: 2.0– 90MHz • VSWR is 1.5:1 or less, continuous • Max Power: 250W SSB/125W FM• Impedance: 50 Ohm • Length: 23' 5" • Weight: 7 lbs. 1 oz. • Conn: SO-239 • Mast Req'd: 1" – 2" dia. • Max wind speed: 67MPH

❷ *Maldol* HVU-8 ULTRA-COMPACT 8 BAND HF/VHF/UHF VERTICAL ANTENNA
80/40/20/15/10/6/2M/70cm Only 1/2 the traditional size and weight of vertical HF antennas, and it includes 2M/70cm! Unique radial system rotates for balcony installations, the radials can all be rotated to one side. • Wavelength: HF and 6M: 1/4 wave • 2M: 1/2 wave • 70cm: Two 5/8waves in phase • Impedance: 50 Ohm • Max Power: HF 200W SSB • 6M–70cm: 150W FM• Conn: SO-239 • Height: Only 8'6" • Weight: 5lbs. 7ozs.

❸ C★MET GP-3 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA
Wavelength: 146MHz 6/8 wave • 446MHz 5/8 wave x 3 • Max Pwr: 200W • Length: 5'11"• Weight: 2lbs. 9ozs. • Conn: Gold-plated SO-239 • Construction: Single-piece fiberglass

❹ C★MET GP-6 DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA
Wavelength: 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 5 • Max Pwr: 200W • Length: 10'2"• Weight: 3lbs. 8ozs. • Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❺ C★MET GP-9 / GP-9N DUAL-BAND 146/446MHZ BASE REPEATER ANTENNA
BEST SELLER! • Wavelength: 146MHz 5/8 wave x 3 • 446MHz 5/8 wave x 8 • Max Pwr: 200W• Length: 16' 9"" • Weight: 5lbs. 11ozs. • Conn: GP-9 Gold-plated SO-239 • GP-9N Gold-plated N-type female • Construction: Fiberglass, 3 Sections

❻ C★MET CX-333 TRI-BAND 146/220/446MHZ BASE REPEATER ANTENNA
Wavelength: 146MHz 5/8 wave x 2 • 220MHz 5/8 wave x 3• 446MHz 5/8 wave x 5 • Max Pwr: 120W • Length: 10'2" • Weight: 3lbs. 1oz.• Conn: Gold-plated SO-239 • Construction: Fiberglass, 2 Sections

❼ C★MET GP-15 TRI-BAND 52/146/446MHZ BASE REPEATER ANTENNA
Wavelength: 52MHz 5/8 wave • 146MHz 5/8 wave x 2 • 446MHz 5/8 wave x 4 • Max Pwr: 150W • Length: 7'11" • Weight: 3lbs. 1oz. • Conn: Gold-plated SO-239• 2MHz band-width after tuning (6M) • Construction: Single-piece fiberglass

NEW
CAA-500MarkII
1.8-500MHz Antenna analyzer

The CAA-500MarkII combines the simplicity and accuracy of an analog instrument, PLUS...a full color LCD graphic display • Resistive (R) and Reactive (X) components of impedance graphed and displayed numerically • SWR readings in both graphic and numerical results.

Operates on 8-16VDC external power, 6 AA Alkaline or NiMH rechargeable cells • Trickle charger built in (only when using NiMH batteries) • Typical battery life: 9 hours of continuous operation • Battery level indicator • Selectable auto power-off time limit preserves battery capacity • SO-239 connector for 1.8-300MHz range • N-female connector for 300-500MHz range

The perfect combination of analog and graphic information, designed in particular for antenna diagnostics and adjustments while on the roof, tower or in the field!

CAA-5SC
Protect your CAA-500MarkII from moisture, shock, dents and dings!
Shoulder strap included.

Call or visit your local dealer today!

www.natcommgroup.com | 800-962-2611

C★MET®

QST

Contents

March 2020 ♦ Volume 104 ♦ Number 3

Columns

Departments

Digital and Mobile Editions

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Write for *QST*

www.arrl.org/qst-author-guide
email: **qst@arrl.org**

Our Cover

The open-wire feed line on our cover is based on Robert Zavrel's, W7SX, step-by-step construction. His rugged open-wire line holds up in difficult weather and works great even under high SWR conditions. For Robert's full instructions — which can be adapted to suit your specifications and the tools you have available — see his article, "Build Your Own Open-Wire Line," on page 30 of this issue.

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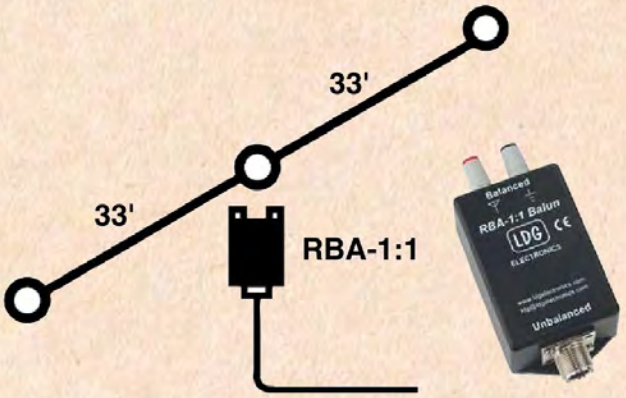
WIRE ANTENNAS for BALUNS & UNUNS

LDG

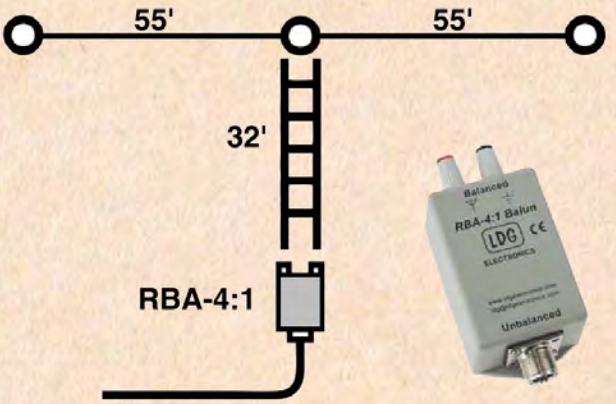
Not sure which wire antenna is right for your LDG Balun or Unun? Check out this handy chart of popular wire antennas. Just add an LDG tuner in your shack with any of these antennas and work mostly 80-10 meters with good results. Visit www.ldgelectronics.com to learn more and see our full line of Amateur accessories.

$30ea. | 200 Watts PEP 1.8-30MHz

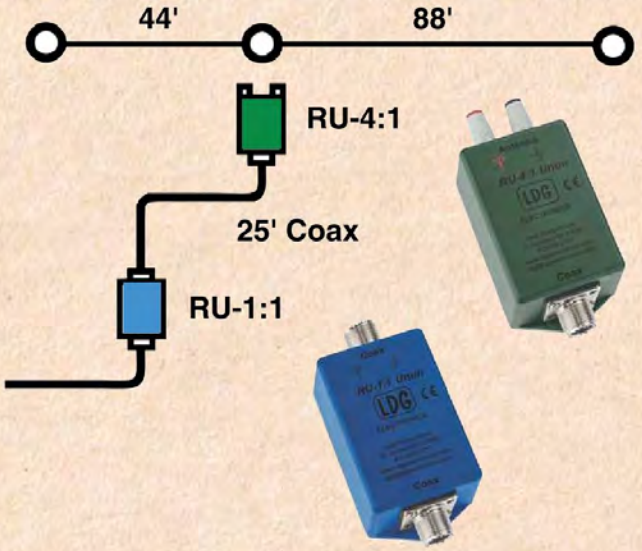
40M DIPOLE



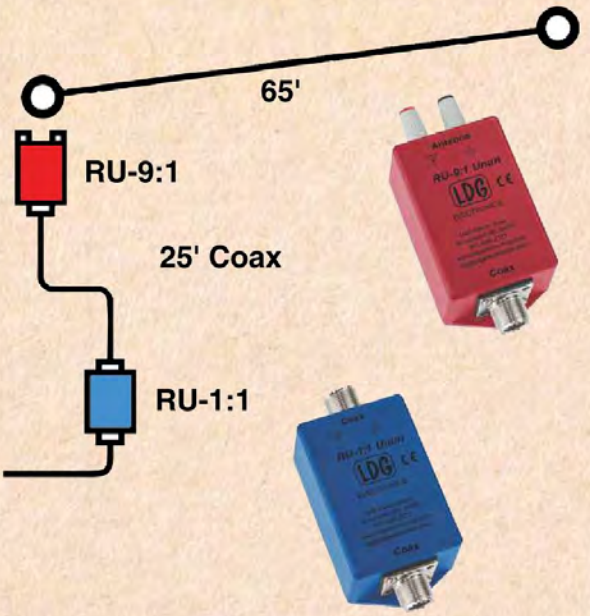
G5RV DIPOLE



OFF CENTER FED WINDHAM



END FED LONG WIRE



410-586-2177 | support@ldgelectronics.com | www.ldgelectronics.com

The SteppIR Advantage

PROBLEM SOLVED!

Yagi antennas are basically single frequency devices that work well only over a very narrow range, typically 0.5% change in frequency. Fixed length yagis compensate by using a variety of techniques, all of which result in serious degradation of performance, especially in Front to Rear rejection, and added complexity, size, and weight. Dipoles have a much broader bandwidth but still cannot cover the entire 80m and 40m bands and maintain a low SWR (<1.5:1). Our patented solution is to simply adjust all of the antenna elements to the optimal length for the desired frequency with none of the compromises in performance that all fixed antennas require. This is accomplished remotely using an electronic controller that can automatically follow the radios' frequency. SteppIR antennas enjoy optimal performance on all frequencies within their specified frequency range (varies by model), and that includes non-ham radio frequencies as well!

THE INHERENT ADVANTAGES OF A STEPPIR:

Create/Modify Mode

The create modify mode allows the user to change the length of each individual antenna element on all bands of operation -and frequencies outside the ham bands as well – and then save the new antennas to memory. This can be incredibly useful to "tune" out potential objects that may be causing interaction with the SteppIR antenna, or to create your own custom antenna designs.

180 Degree Mode

The 180 degree mode feature is one of the most popular among SteppIR owners. For our Yagi antennas, this feature allows a user to electrically "rotate" the antenna from the forward beam heading, to the reverse (180 degrees) beam heading, with a click of a button – the entire process takes approximately 2 seconds.

Bi-Directional Mode

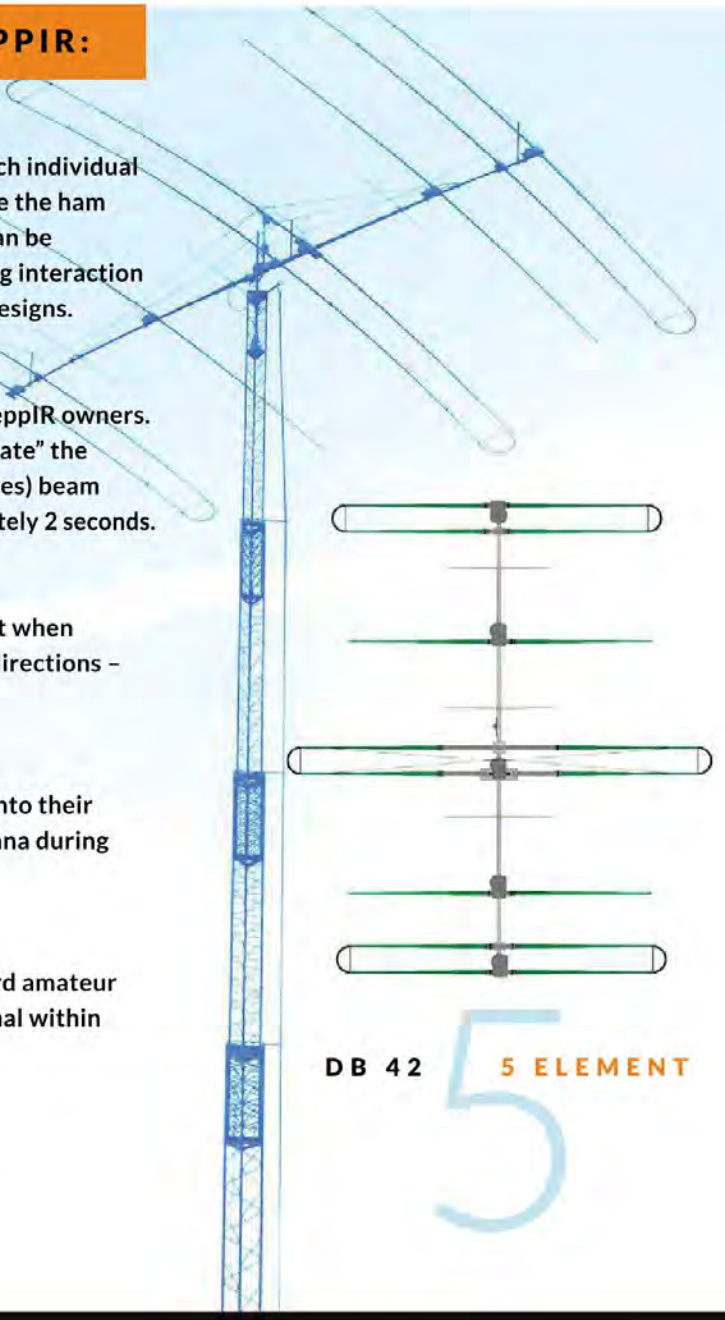
The bi-directional mode works similarly to the 180 function, except when enabled, the Yagi antenna will now be operating with gain in both directions – forward and backwards, simultaneously!

Retract Elements

With a touch of a button, SteppIR antennas can be fully retracted into their housing, which helps to protect the most valuable part of the antenna during extreme weather events.

Emergency Communications

Many times, emergency communications occur outside the standard amateur radio allocated bands of operation. All SteppIR antennas are optimal within the entire scope of their specified frequency range.



DB 42 5 ELEMENT

steppIR COMMUNICATION SYSTEMS

SEE ALL OF STEPPIR'S ANTENNAS: www.steppir.com 425-453-1910

DIAMOND ANTENNA

diamondantenna.net

When it comes to quality and performance, DIAMOND ANTENNA is the worldwide leader in VHF/UHF base and mobile antennas.

DIAMOND ANTENNAS help you get the most out of your on-air experience.

For all your base station and repeater needs, DIAMOND has an antenna that will work for you.

You've tried the rest, now own the best!

X700HNA Special Features:

- Heavy duty fiberglass radomes
- Four section assembly
- Overlapping outer shells for added strength
- Stainless steel mounting hardware & radials
- Strong waterproof joint couplings
- Type-N cable connection
- Wideband performance
- Highest gain Dual-band Base Antenna!

Here is a small sample of our wide variety of antennas

Model	Bands	Length Ft.	Max Pwr. Rating	Conn.
Dualband Base Station/Repeater Antennas				
X700HNA (4 section)	2m/70cm	24	200	N
X510HD (3 Section)	2m/70cm	17.2	330/250	UHF or N
X300A (2 Section)	2m/70cm	10	200	UHF or N
X200A (2 Section)	2m/70cm	8.3	200	UHF
X50A (1 Section)	2m/70cm	5.6	200	UHF or N
X30A (1 Section)	2m/70cm	4.5	150	UHF
Monoband Base Station/Repeater Antennas				
F23H (3 Section)	144-174 MHz (W/ Cut Chart)	15	350	UHF
F22A (2 Section)	2m	10.5	200	UHF
CP22E (Aluminum)	2m	8.9	200	UHF
F718A (Coax Element)	70cm	15	250	N
Dualband Mobile Antennas				
SG7900A	2m/70cm	62.2 in.	150	UHF or NMO
SG7500A	2m/70cm	40.6 in.	150	UHF or NMO
NR770H Series	2m/70cm	38.2 in.	200	UHF or NMO
MR77 Series	2m/70cm	20 in.	70	Mag Combo
AZ504FXH	2m/70cm	15.5 in.	50	UHF
AZ504SP	2m/70cm	15.5 in.	50	UHF
NR7900A	2m/70cm	57 in.	300/250	UHF
Monoband Mobile Antennas				
NR22L	2m	96.8 in.	100	UHF
M285	2m	52.4 in.	200	UHF or NMO

The Standard By Which All Others Are Judged

RF PARTS™ COMPANY

Diamond Antenna is a division of RF Parts Company

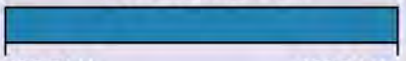
US Amateur Radio Bands

Operator license classes: **E** = Amateur Extra **A** = Advanced **G** = General **T** = Technician **N** = Novice
CW operation is permitted throughout all amateur bands. Except as noted, all frequencies are in megahertz (MHz).

= RTTY, data, phone, image = USB phone, RTTY, data and CW = RTTY and data = phone and image
= SSB phone = CW only

LF – Low Frequency band

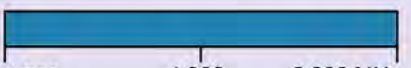
2200 Meters (135 kHz) E,A,G
1 W EIRP maximum



MF – Medium Frequency bands

630 Meters (472 kHz) E,A,G
5 W EIRP max, except in Alaska within 496 miles of Russia where the limit is **1 W EIRP**

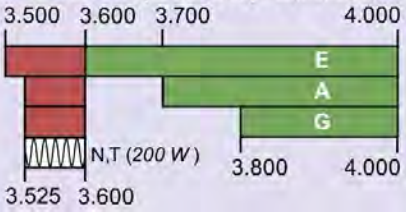
160 Meters (1.8 MHz) E,A,G



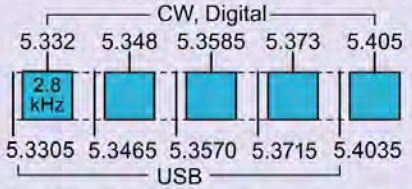
Amateurs wishing to operate on **2200 or 630 meters** must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/.** You need only register once for each band.

HF – High Frequency bands

80 Meters (3.5 MHz) E,A,G,T,N

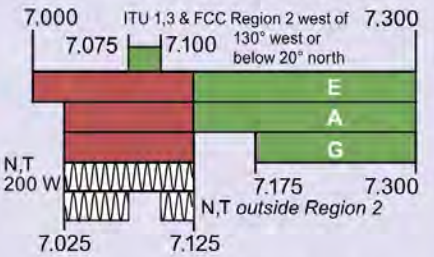


60 Meters (5.3 MHz) E, A, G (100 W)

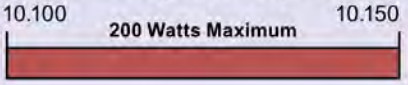


Gen, Adv, and Extra licensees may operate on a secondary basis with a maximum ERP of 100 W maximum.

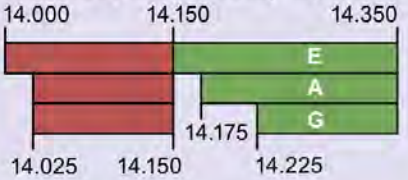
40 Meters (7 MHz) E,A,G,T,N



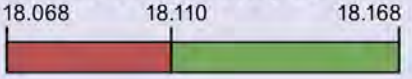
30 Meters (10.1 MHz) E,A,G



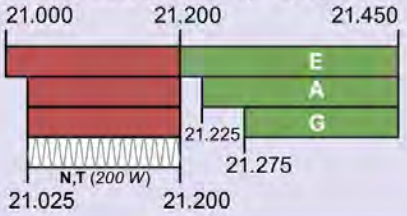
20 Meters (14 MHz) E,A,G



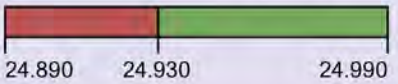
17 Meters (18 MHz) E,A,G



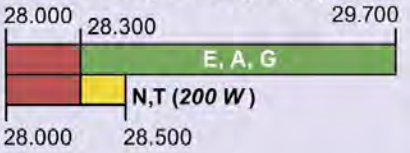
15 Meters (21 MHz) E,A,G,T,N



12 Meters (24 MHz) E,A,G

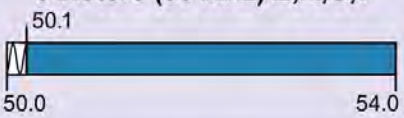


10 Meters (28 MHz) E,A,G,T,N

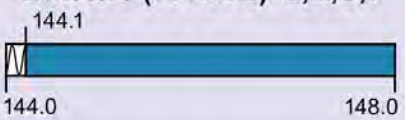


VHF – Very High Frequency bands

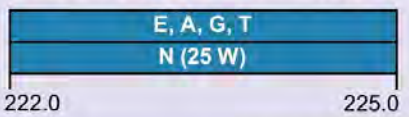
6 Meters (50 MHz) E,A,G,T



2 Meters (144 MHz) E,A,G,T

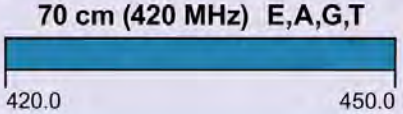


1.25 Meters (222 MHz) E,A,G,T,N



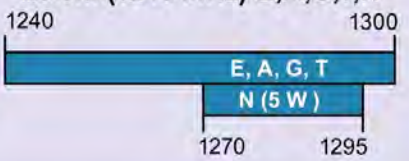
UHF – Ultra High Frequency bands

70 cm (420 MHz) E,A,G,T



33 cm (902 MHz) E,A,G,T

23 cm (1240 MHz) E,A,G,T,N



SHF&EHF – Super and Extremely High Frequency bands

All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	3300-3500 MHz	10.0-10.5 GHz	47.0-47.2 GHz	122.25-123.0 GHz	241-250 GHz
2390-2450 MHz	5650-5925 MHz	24.0-24.25 GHz	76.0-81.0 GHz	134-141 GHz	All above 275 GHz

See www.arrl.org/band-plan for detailed band plans.

OTAbands **rev. 11/8/2019**

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...are stronger, lighter, have less wind surface and last years longer.

Why? hy-gain uses durable tooled components – massive boom-to-mast bracket, heavy gauge element-to-boom clamps, thick-wall swaged tubing – virtually no failures!

TH-11DX, $1299.95. 11-element, 4.0 kW PEP, 10, 12, 15, 17, 20M

The choice of top DXers.

With 11-elements, excellent gain and 5-bands, the super rugged TH-11DX is the "Big Daddy" of all HF beams!

Handles 2000 Watts continuous, 4000 Watts PEP.

Every part is selected for durability and ruggedness for years of trouble-free service.

Features a low loss logperiodic driven array on all bands with monoband reflectors, BN-4000 high power balun, corrosion resistant wire boom support, hot dipped galvanized and stainless steel parts.

Stainless steel hardware and clamps are used on all electrical connections.

TH-7DX, $999.95. 7-element, 1.5 kW PEP, 10, 15, 20 Meters

7-Elements gives you the highest average gain of any hy-gain tri-bander!

Dual driven for broadband operation without compromising gain. SWR less than 2:1 on all bands.

Uniquely combining monoband and trapped parasitic elements give you an excellent F/B ratio.

Includes hy-gain's diecast aluminum, rugged boom-to-mast clamp, heavy gauge element-to-boom brackets, BN-86 balun. For high power, upgrade to BN-4000.

Compact 3-element 10, 15, 20 Meter Tri-Bander

For limited space...Installs anywhere...14.75 ft turning radius... weighs 21 lbs...Rotate with CD-45II, HAM-IV

Fits on light tower, suitable guyed TV pole, roof tri-pod

TH-3JRS, $419.95. hy-gain's most popular 3-element 10, 15, 20 Meter tribander fits on most lots! Same top performance as the full power TH3MK4 in a compact 600 watt PEP design.

Excellent gain and F/B ratio let you compete with the "big guns".

Tooled manufacturing gives you hy-gain durability with 80 MPH wind survival.

TH-5MK2, $879.95. 5-element, 1.5 kW PEP, 10,15, 20 Meters

The broadband five element TH5-MK2 gives you outstanding gain.

Separate air dielectric Hy-Q™ traps let you adjust for maximum F/B ratio on each band.

Also standard is hy-gain's exclusive BetaMATCH™, stainless steel hardware and compression clamps and BN-86 balun.

TH-3MK4, $549.95. 3-element, 1.5 kW PEP, 10,15, 20 Meters

The super popular TH-3MK4 gives you the most gain for your money in a full-power, full-size durable hy-gain tri-bander!

You get an impressive average gain and a whopping average front-to-back ratio. Handles a full 1500 Watts PEP. 95 MPH wind survival.

Fits on average size lot with room to spare -- turning radius is just 15.3 feet.

Four piece boom is ideal for DXpeditions. Rotates with CD-45II or HAM-IV rotator.

Features hy-gain BetaMatch™ for DC ground, full power Hy-Q traps, rugged boom-to-mast bracket and mounts on standard 2"O.D. mast. Stainless steel hardware. BN-86 balun recommended.

TH-2MK3, $449.95. 2-element, 1.5 kW PEP, 10,15, 20 Meters

The 2-element TH-2MK3 is hy-gain's most economical full power (1.5kW PEP) full size tri-bander.

For just $339.95 you can greatly increase your effective radiated power and hear far better!

Ruggedly constructed, top-performing, compact 6 foot boom, tight 14.3 foot turning radius. Installs almost anywhere. Rotate with CD-45II or HAMIV. BN-86 balun recommened.

EXP-14, $699.95. 4-element, 1.5 kW PEP, 10,15, 20 Meters

Revolutionary 4-element compact tri-bander lets you add 40 or 30 Meters! Has 14 foot boom and tight 17.25 feet turning radius. Fits on roof tri-pod, mast or medium duty tower.

hy-gain's patented broadbanding Para Sleeve gives you less than 2:1 VSWR. 1.5kW PEP.

BetaMATCH™ provides DC ground to eliminate static. Includes BN-86 balun. Easily assembled.

Truly competitive against giant tri-banders at half the cost!

QK-710, $199.95. 30/40 Meter option kit for EXP-14.

Tooled Manufacturing... Highest Quality Materials

1. **hy-gain's** famous super strong tooled die cast Boom-to-Mast Clamp
2. **Tooled** Boom-to-Element Clamp
3. **Thick-wall** swaged aluminum tubing

Tooled manufacturing is the difference between hy-gain antennas and the others -- they just don't have it (it's expensive!).

Die-cast aluminum boom-to-mast bracket and element-to-boom compression clamps are made with specially tooled machinery.

hy-gain antennas feature tooled swaged tubing that is easily and securely clamped in place. All tubing is deburred and cleaned for smooth and easy assembly.

Durable precision injection molded parts.

hy-gain antennas are stronger, lighter, have less wind surface area, better wind survival, need no adjustments, look professional and last years longer.

Model No.	No. of elements	avg gain dBd	avg F/B dB	MaxPwr watts PEP	Bands Covered	Wind sq. ft. area	Wind (mph) Survival	Boom feet	Longest Elem. (ft)	Turning radius (ft)	Weight (lbs.)	Mast dia O. D. (in.)	Recom. Rotator	Sugg. Retail
TH-11DX	11			4000	10, 12, 15, 17, 20	12.5	100	24	37	22	88	1.9-2.5	T2X	$1299.95
TH-7DX	**7**	**For Gain and F/B ratio–See...**		**1500**	**10, 15, 20**	**9.4**	**100**	**24**	**31**	**20**	**75**	**1.5-2.5**	**HAM-IV**	**$999.95**
TH-5MK2	5			1500	10, 15, 20	7.4	100	19	31.5	18.42	57	1.5-2.5	HAM-IV	$879.95
TH-3MK4	**3**	• www.hy-gain.com		**1500**	**10, 15, 20**	**4.6**	**95**	**14**	**27.42**	**15.33**	**35**	**1.9-2.5**	**CD-45II**	**$549.95**
TH-3JRS	3	• hy-gain catalog		600	10, 15, 20	3.35	80	12	27.25	14.75	21	1.25-2.0	CD-45II	$419.95
TH-2MK3	**2**	• Call toll-free 800-973-6572		**1500**	**10, 15, 20**	**3.25**	**80**	**6**	**27.3**	**14.25**	**20**	**1.9-2.5**	**CD-45II**	**$449.95**
EXP-14	4			1500	10, 15, 20 opt.30/40	7.5	100	14	31.5	17.25	45	1.9-2.5	HAM-IV	$699.95

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THE INRAD DESK MICROPHONE SYSTEM IS THE NEW STANDARD FOR QUALITY AUDIO ON HF. Excellent audio doesn't have to cost hundreds of dollars. Prices from $138 to $158. QST review: January 2018.

W1 HEADSET $179

INRAD W1 HEADSET

THE INRAD W1 HEADSET IS THE NEW HAM RADIO STANDARD. Great comfort. Great audio. Great price. THOUSANDS IN USE WORLDWIDE QST review: May 2019

VIBROPLEX AND BENCHER CW Keys – The BENCHER BY-1 is the best selling iambic paddle in Amateur Radio! Iambic paddles, straight keys, bugs, single lever paddles, accessories and more.

BENCHER, INC.

EASY-ROTOR-CONTROL

USB control of 90 different rotators. Point and click with your mouse. Interfaces with most popular ham software. Kit and assembled versions start at only $99. AZ/EL controllers also available. *QST* review: Nov. 2014.

DXPatrol is a tiny SDR covering 100 kHz-2 GHz that can be used with Windows, Mac, Linux, or Android. Not an 8-bit dongle! Full featured receiver. Want to add a panadaptor to your HF transceiver? Do it with DXPatrol. Great price at only $99.95!

$99.95

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THE SPIDERBEAM 40FT HD FIBERGLASS POLE HAS NO EQUAL IN HAM RADIO

One pole, many uses, made to withstand years of portable or permanent installation.

SPIDERBEAM HD FIBERGLASS POLES 40 ft - $109 and $119 / 60 ft - $279 / 72 ft - $479 / 85 ft - $599. QST review: Feb. 2010

SPIDERBEAM ROTATABLE ALUMINUM MASTS - support for 13 to 26 lbs antenna weight. 33 ft - $459 / $485, 41 ft $509, 47 ft $639, 49 ft $575, 60 ft $749. Guy hardware, rotator adapters, other accessories available. QST review: May 2015.

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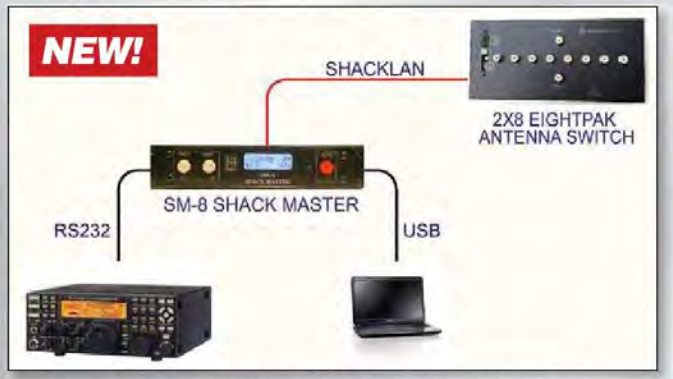
Wiring are simple phone cables that daisy chain to all the devices. Wireless control is also available to your tower-located switches. Call us to learn how to set up simple or complex systems. Below is a simple basic system that can switch antennas as you change bands. We can interface to any radio CAT port, not just RS232.



A more complex system could be a SO2R contest station as shone.

The Shared Apex Loop Array™!

Capture the whole band or the whole HF spectrum at once with the Shared Apex Loop Array 2nd Generation. Can be remote controlled over the internet or in your station. 8 directions of directivity.

The Shared Apex Loop Array™ is a revolutionary receiving antenna that will change the way that you listen to the radio! The patented design provides performance in a size and over a wide range of frequencies that will please both the rag-chewer and DXer alike.

Three models to choose from:

- AS-SAL-30 - optimized for VLF, BCB, 1.8-10 MHz
- AS-SAL-20 - optimized for BCB, and 1.8-30 MHz
- AS-SAL-12 - optimized for 3-30 MHz

StackMatch

The original, not the imitations. For phasing 2, 3, 4 and even 6 antennas. Also it can be used to combine vertical and horizontal polarized antennas to diminish fading.

PowerMaster II

RF Power and SWR meter. Couplers for 3 kW, 10 kW or higher available for HF/6 m. VHF and UHF couplers for 1.5 kW. You can connect up to 5 couplers to the display to monitor RF power on different TX lines.

OM2000A+ – OM2000+

The **OM2000A+** is the lightest and smallest 2000 W fully automatic HF/6 m power amplifier in the market. Its manual tuning version, the **OM2000+**, is our affordable unmatched best-seller.

Frequency coverage:
Amateur bands 1.8 – 29.7 MHz including WARC + 50 MHz

Power output: 2000+ W in SSB/CW on HF bands, 1500 W in RTTY
1500 W CW/SSB on 50 MHz

Coming soon the new **OM2501HF/A** and **OM4001HF/A** amplifiers.
Additional features and functionality.
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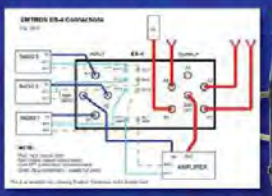
NEW!

An innovative radio, amp, and antenna switch. Routes one of two radios to a single amplifier and then to two antenna outputs. Solves the problem of tedious manual hookups if you have more than one radio. Also routes PTT and ALC lines. Introductory pricing $195.00



Switches for Six Antennas

5kW - DC to 6m

RATPAK – 1x6

Choice of Multiple Controllers

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Surge Arrestors

AS-302, AS-303 Coaxial cable arrestors. DC to 500 MHz. N-type or SO-239 connectors. **AS-300SB** Stacking fixture available. **AS-309H**, ladder line arrestor. All have static bleed function. **AS-8SP**, **AS-12SP** and **AS-16SP** control cable arrestors. Protect your rotator's and other control cables.

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Ratios 1:1, 1:2, 2:1,4:1 and more. RF line isolators. Ratings 3, 5, 10 kW+. Get the most out of your antenna by stopping the coaxial cable from becoming part of it.

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Array Solutions' products are in use at top DX and Contest stations worldwide as well as commercial and governmental installations. We provide RF solutions to the DoD, FEMA, Emcomm, UN, WFO, FAA and the State Dept. for products and installation of antennas systems, antenna selection, filtering, switching and grounding. We also offer RF engineering and PE consulting services.

Caroline Kenney, ckenney@arrl.org

Member Spotlight

Edward Finnegan, K9ECF

Edward Finnegan, K9ECF, takes amateur radio to the skies with his work as an American Airlines pilot and as a certified aviation instructor and check airman.

Taking Flight

Ed is a former Army aviator, having received his Airline Transport Pilot certificate with over 18,000 hours of flight time. While on active duty, he flew helicopters and fixed-wing aircraft on reconnaissance missions along the sensitive borders of the Republic of Korea and West Germany. It was during this time that he first became interested in amateur radio, specifically HF radios.

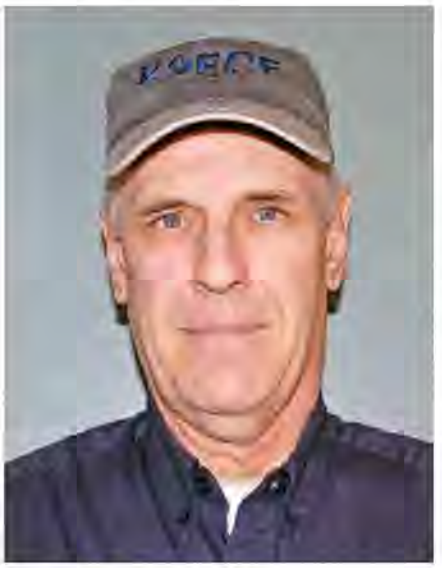
He left active duty to fly for American Airlines in 1990, but his interest in amateur radio continued. He earned his Technician license in November 2012, and upgraded to General only 1 month later.

Radio at 37,000 Feet

Ed said that his favorite aspect of amateur radio is that there are so many directions you can take with the hobby, and it can overlap with so many other interests. "There seems to be something for everyone," he said, "whether it's analog or digital, old or new technology, or operating on the ground or in the air."

Naturally, Ed combined his interests in amateur radio with his love of flying, saying he enjoys making "aeronautical mobile contacts." He particularly likes making overhead contacts with his brother, Tom, K3TRF, whom Ed convinced to get his license.

Workload permitting and recognizing that his first priority is safely flying the aircraft, Ed even makes contacts while airborne in the B-737. Using his altitude to his advantage, he is able to act as a relay station for various maritime mobile service nets. "You can hear a lot at 37,000 feet!" he said.



Edward Finnegan, K9ECF.

Ed is not alone in enjoying the natural intersection of these two worlds. AirVenture Oshkosh is the largest annual gathering of aviators, but it is also a great place to celebrate the overlap of aviation and ham radio. Many pilots carry handheld radios for various backup communications and for talking with other hams as they fly overhead.

As a board member and Chairman of the Safety Committee for Warbirds of America, Ed participated in their EAA 2019 AirVenture exhibit, where he helped Warbirds of America set up a special event radio station (W9W), highlighting their contribution to the world event and to ham radio.

Finnegan Aviation Services

Ed is a certified flight instructor and ground instructor with primary, multi-engine, and instrument ratings. He flies a variety of aircraft within the warbird community, and has recently been authorized by the FAA to provide practical test services to general aviation.

With these certifications, Ed was able to start Finnegan Aviation Services, LLC. in support of the FAA's Vintage and Surplus Military Aircraft program, Ed is a designated specialty aircraft examiner. Through Finnegan Aviation Services, he acts as a check airman for World War II-, Korean War-, and Vietnam War-era aircraft, "which I also fly for enjoyment on my days off." He ensures that a pilot's training and skills are up to FAA standards before they are permitted to fly the aircraft by themselves. He is qualified to conduct specialized instruction, proficiency and competency checks, and ferry services for maintenance and relocation.

Homebrewing

Ed still uses the first radio he purchased, an Icom-746, and enjoys DIY antenna building. Being a pilot, his first homebrew experience was with a homebrew ground-plane antenna for the aviation band, and a homebrew ground-plane antenna for 10 to 11 meters. Surprised that they worked as well as they did, Ed tried something a little bigger, building a 33-foot homebrew vertical.

Giving Back

Ed feels that it is important for hams to give back to the community. He is a RACES volunteer, supporting the McHenry County, Illinois, Emergency Management Agency in their emergency communications division. You can catch him on the 6 – 80 meter bands.

Guide to Member Benefits

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Advocacy | www.arrl.org/regulatory-advocacy

ARRL supports legislation and regulatory measures that preserve and protect meaningful access to the radio spectrum. Our **ARRL Regulatory Information Branch** answers member questions concerning FCC rules and operating practices. **ARRL's Volunteer Counsel** and **Volunteer Consulting Engineer** programs open the door to assistance with antenna regulation and zoning issues.

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- **Liberty Mutual Auto and Home Insurance**

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The American Radio Relay League, Inc.

ARRL, the national association for Amateur Radio® in the United States: supports the awareness and growth of amateur radio worldwide; advocates for meaningful access to radio spectrum; strives for every member to get involved, get active, and get on the air; encourages radio experimentation and, through its members, advances radio technology and education; and organizes and trains volunteers to serve their communities by providing public service and emergency communications *(ARRL's Vision Statement, adopted in January 2016).*

ARRL is an incorporated, noncommercial association without capital stock chartered under the laws of the State of Connecticut, and is an exempt organization under Section 501(c)(3) of the Internal Revenue Code of 1986. Its affairs are governed by a Board of Directors, whose voting members are elected every 3 years by the general membership. The officers are elected or appointed by the Directors.

ARRL is noncommercial, and no one with a pervasive and continuing conflict of interest is eligible for membership on its Board.

"Of, by, and for the radio amateur," ARRL numbers within its ranks the vast majority of active amateurs in the nation and has a proud history of achievement as the standard-bearer in amateur affairs.

A *bona fide* interest in amateur radio is the only essential qualification of membership; an amateur radio license is not a prerequisite, although full voting membership is granted only to licensed amateurs in the US.

Membership inquiries and general correspondence should be addressed to the administrative headquarters: ARRL, 225 Main St., Newington, Connecticut 06111-1400 USA.

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The 15 Divisions of ARRL are arranged into 71 administrative *Sections*, each headed by an elected *Section Manager* (SM). Your Section Manager is the person to contact when you have news about your activities, or those of your radio club. If you need assistance with a local problem, your Section Manager is your first point of contact. He or she can put you in touch with various ARRL volunteers who can help (such as Technical Specialists).Your Section Manager is also the person to see if you'd like to become a Section volunteer. Whatever your license class, your SM has an appointment available. Visit your Section page at **www.arrl.org/sections**.

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Up Front

On The Air from a Lofty Perch

Tim Carter, W3ATB, grabbed this photo of Jim Cluett, W1PID, operating from just below the summit of Cannon Mountain in New Hampshire. For Tim, the pun was irresistible: "I guess you'd say Jim had a *leg up* on all the other operators from this elevation."

Summer School

Zach Kline, KD9LDT (shown on the mic), conducted four Radio Merit Badge classes at the Loud Thunder Scout Reservation summer camp in Illinois City, Illinois last summer during a 5-week period from June 14 to July 12. Zach, who is an Eagle Scout and holds an Amateur Extra-class license, helped approximately 65 Scouts complete and receive their Radio Merit Badges at the camp. Each Friday, he set up a portable HF station under a tent, with members of the River Bend Wireless Operators Club providing additional training in Morse code and foxhunting.

A Proud Moment

Prospective hams Mari Ann Stevenson and her daughter Solana Stevenson operated the Williamsburg Area Amateur Radio Club's "Get On The Air" station during ARRL Field Day 2019, under the tutelage of club vice president Chuck White, AI4WU (left), as their proud father and grandfather Randy Altona, KM4YSN (right), looked on. Mari Ann and Solana passed their Technician exams last fall, earning the call signs KN4ZMH and KN4ZMG respectively, and Randy upgraded to a General-class license at the same time. [George Ewart, WG4F, photo]

The Graduates Wore Camo

US Marines with the 2nd Radio Battalion of the II Marine Expeditionary Force Information Group; a British Royal Marine Commando with the Marine Corps Foreign Personnel Exchange Program, and civilians with the Brightleaf Amateur Radio Club in Greenville, North Carolina posed for a photo at the conclusion of an amateur radio licensing course at Camp Lejeune in Jacksonville, North Carolina last October. The objective of the course was to increase the Marines' knowledge of amateur radio in particular, and radio operating procedures in general. The club taught 20 students and finished with 19 new Technician licensees and two upgrades to General. The classes are part of a cooperative effort between the club and the Marine Corps. [Corporal Livingston, photo]

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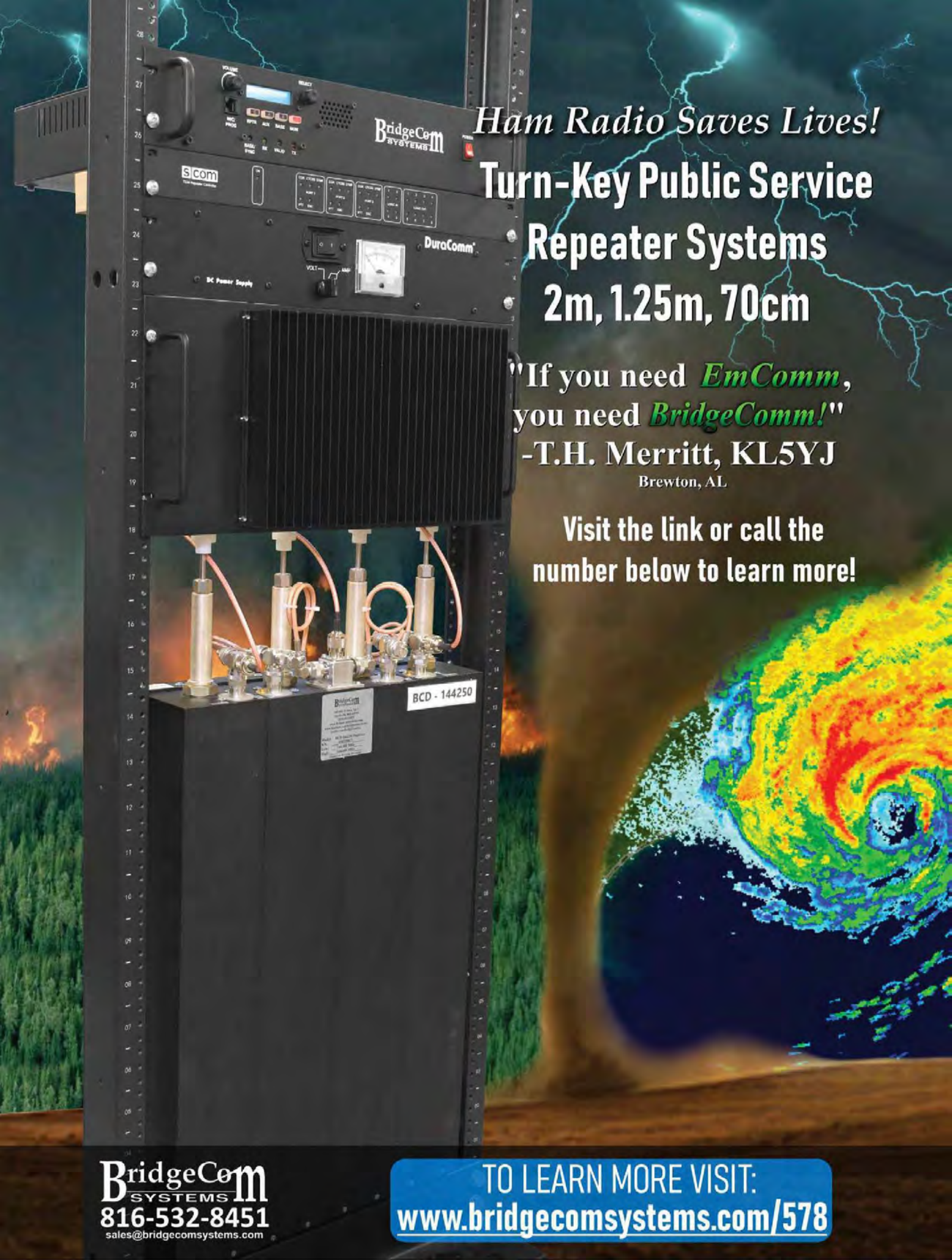
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Correspondence

Letters from Our Members

ARRL on Classic TV

While watching old TV shows on YouTube, I came across the 1950s show *Highway Patrol*, which is about the action-packed adventures of fictional highway police. In the episode, "Radio Active," ARRL is not only mentioned, but plays a part in the rescue. There are also some nice scenes of a '50s-era shack and the "new" boatanchors adorning it. Watch the episode on YouTube at **https://youtu.be/mMLpy8l87bY**.

Dave Berman, WA2PAY
St. Augustine, Florida

Embracing Change

I've been thinking about amateur radio and our hope that the hobby will continue to grow in the future. How amateur radio embraces change will determine our survival.

The most important thing that any ham can have, whether they have years of experience or are just starting out, is the willingness to look at new ideas and ways of doing things with an open mind. The concept of "That's how we've always done it" will be our death. As hams, we must be willing to embrace the younger generation and open our hobby to the makers of the world. Today, we have new concepts like digital modes using computers instead of microphones or keys. The building is often in software instead of soldering irons.

The ability to adapt and accept change is one of the basic principles of evolution. If we as hams do not look forward to new technology and embrace change brought by the next generation, we are doomed to extinction. I don't mean to say we need to give up all our traditions, but we must be willing to teach the next generation so they can take those traditions to the next level.

Be a mentor, not one of the people saying, "That's not ham radio."

Mike Walters, W8ZY
New Milford, Connecticut

Touring W1AW

In the summer of 1973 (when my call was WA9PGF), I visited W1AW at ARRL Headquarters to take a tour. The W1AW team set up one of their radios with the rhombic antenna pointed due west. (The rhombic has since been taken down.) You can imagine my friend Ron's, W9MAF, surprise when he called my mobile rig and got W1AW booming in at S9 + 10 dB.

I am now retired and living in Michigan, but Ron agreed to repeat at least some of that adventure we had. In late 2019, during a week exploring the fall colors in New Hampshire, I again visited ARRL Headquarters and was treated to a great tour of W1AW thanks to my hosts — Dan Arnold, W1CNI; Steve Ewald, WV1X, and Liz Karpiej, KA1DTU.

Ron and I did make contact that morning and relived one of the more memorable radio contacts I have had the pleasure of making since becoming a ham in 1963. I hope that any amateur radio operator takes the opportunity to tour ARRL Headquarters and become more aware of all that ARRL membership holds. Ham radio has helped me make new friends, maintain contact with those who have moved miles away, and to participate in many facets of this fascinating hobby.

Don Hruby, K9DH
Ada, Michigan

Remembering Professor Regier, OD5CG

I was extremely moved when I read "100, 50, 25" in the December 2019 issue and saw the excerpt about Frank Regier, OD5CG (SK).

Professor Regier was the chairman of the Electrical and Computer Engineering Department, Faculty of Engineering and Architecture at the American University of Beirut in Lebanon. I was a student of his from 1981 to 1982. While reading about his "trapless triband vertical antenna" mentioned in the magazine, I fondly remembered being in a group of students constructing a helical antenna for microwave frequencies that he designed and supervised. We installed it on the rooftop of the Faculty of Engineering and Architecture building and were able to conduct two-way communication using his call sign as a control operator.

I am very thankful to you to have mentioned him. All his students, with no exception, have very fond memories of a dedicated, clear-minded, and top-class engineer and educator.

Dr. Ghassan Chammas, OD5YA
Beirut, Lebanon

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W1AW's QSL File

Every month, W1AW receives hundreds of QSL cards from hams all over the world, confirming contact with the Hiram Percy Maxim Memorial Station at ARRL Headquarters. Maybe you'll recognize an on-air friend — or even yourself — among these recent cards.

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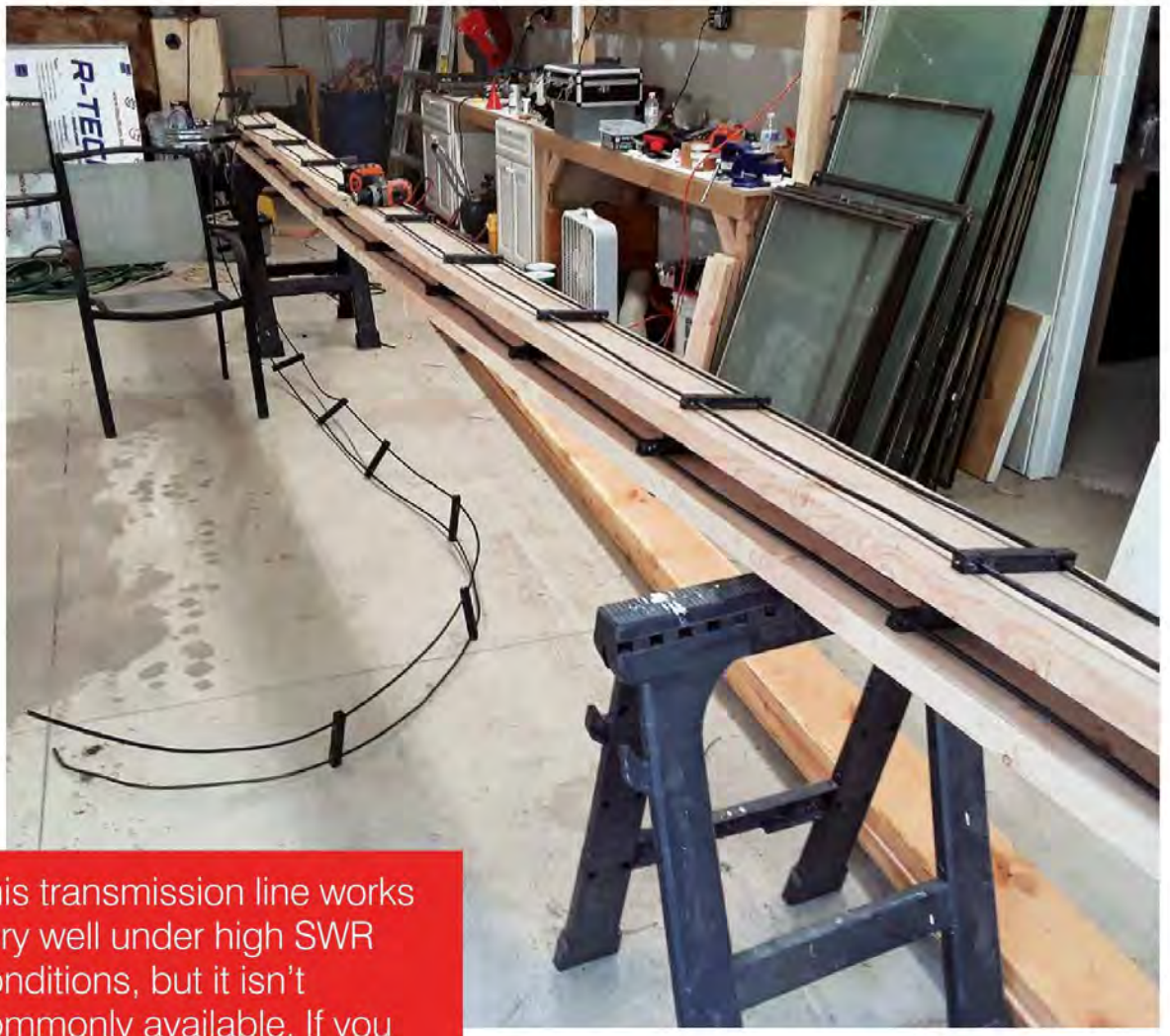

This transmission line works very well under high SWR conditions, but it isn't commonly available. If you can't buy it, build it!

Open-wire line with spacers every 2 feet, shown under construction.

Robert J. Zavrel, Jr., W7SX

Amateurs have been building their own open-wire feed lines for decades, and there are many variations on the same theme. Perhaps the greatest incentive for choosing open wire and/or ladder line over coaxial lines is to reduce transmission line loss, especially for operation under high SWR conditions. Table 1 shows a comparison of three basic types of transmission line. This is how I built a particularly rugged line that is rated for high power and is more than capable of withstanding the ravages of weather. You don't need to follow my approach exactly; adapt my technique to your situation and the materials (and tools) you have on hand.

Materials

My line uses #6 AWG stranded aluminum outdoor black wire. Electrical wire specified for outdoor uses polyethylene (XHHW) insulators and black improves the resistance to UV solar radiation. I also chose polyethylene plastic for the spreaders to minimize dielectric losses.

Table 1
Summary of Relative Advantages and Disadvantages of the Three Basic Types of Lines

Type	Line Loss	Ease of Installation	Arcing Risk	Aging	Noise Pick-Up	SWR Tolerance
Coaxial	Worst	Best	Worst	Worst	Best	Worst
Ladder Line	Better	Better	Better	Better	Better	Better
Open Wire	Best	Worst	Best	Best	Worst	Best

Polyethylene is notorious for not bonding well with glue. However, I did find an adhesive that works well (3M part number 4693H), but it requires some care. The 5-ounce tube was just enough for 200 feet of line using 100 spreaders.

For spreader material, I selected ⅜-inch-thick sheets of black polyethylene. Polyethylene is very easy to cut on a wood-cutting table saw using standard wood-cutting blades. I also used a standard wood-cutting dado set to cut the grooves to accept the wires and provide a tight fit into the plastic. When using smaller wire, a standard wood-cutting blade might also serve to cut the groove in the polyethylene. You want a snug fit, so some experimenting will likely be necessary to find the right groove width and depth for a given wire.

Using #6 AWG aluminum results in a slightly lower loss than #12 AWG copper. However, the much larger aluminum wire is stronger than copper and lighter for its strength. A #6 AWG copper wire would be heavier, but would provide a super low-loss line.

Each spreader comprises two polyethylene plastic parts machined on a woodworking table saw. The center-to-center spacing of the wires, and thus also the dado grooves, is 4¼ inches. This provides for a 450 Ω line impedance allowing seamless connection to commercial 450 Ω ladder line. When the two parts are glued together, the spacers are ¾ × ¾ × 5¼ inches with the wires sandwiched into the dado grooves.

Each spreader comprises two polyethylene plastic parts.

For my construction platform, I used 20-foot-long, 2 × 8 inch standard framing lumber boards supported by sawhorses at each end.

Building the Line

The first step is to cut the wires. I built the line in 100-foot sections, then connected them together when installing the line using standard splice/reducers. The two lines are stretched reasonably tight on the board and held in place with C clamps. I employed unglued spreaders to keep the spacing accurate and constant over the length.

Framing lumber supported by sawhorses at each end make the construction platform.

The spacers are placed every 2 feet along the line length. The adhesive is applied to the lower part, including inside the groove. A bit of experimenting with the amount will yield how much to apply as you continue. Adhesive is also applied to the upper half of the spacers' grooves. I then used 1¼-inch sheetrock screws to hold the assembly in place while the adhesive set up. The screws self-tap through the two plastic spacer pieces and also down into the wood. I used two screws per spacer, each close to the wire on the inside of the spacers.

Connect transmission sections together with standard splice/reducers.

When finishing one run, I simply flipped the board over and continued assembly in the opposite direction on the other side of the board. I then placed another board on top and did the same thing. Each board will then have a bit more than 40 feet of finished line. Three boards will hold the entire 100-foot segment. I wore rubber gloves to keep the industrial-strength adhesive off my hands. I let the adhesive set for 24 hours under the pressure of the screws. Then, I simply removed the screws and the line was finished.

At 7 MHz, 500 feet of this line has just 0.25 dB of matched loss. With an SWR of 15:1 on the line, my total loss was about 1 dB. The losses at 1.8 and 3.5 MHz are even lower. For matched conditions, a 450 Ω line could use 9:1 baluns at either end and thus offer a direct replacement for a 50 Ω coaxial run.

Installing the Line

I hung the line from trees at least 10 feet high to prevent contact with moose antlers (a common occurrence on my remote property). There are many ways of hanging the line. I used 1 × 1 inch lengths of polyethylene attached to the wires with 3/16-inch wire rope clamps with the saddles of the clamps biting into the wire insulation and tightening them down to the poly support. Then I used an eye bolt screwed into a tree limb (or offset from the trunk) and a small rope threaded through the eye hook to raise or lower the line. On one 70-foot run, I utilized a counterweight and pulley to compensate for snow and wind loads.

The adhesive used in the spacers is not strong enough for line support, so I used a larger piece of polyethylene and fastened them to the plastic with 3/16-inch wire rope clips. Then I used aluminum **U**-channel to connect the assembly to a rope. Rope clips come with **U** bolts, which I replaced with galvanized ¼-inch bolts and nuts.

The rope passes through a pulley at the top of a 4 by 6 pressure-treated post and is then tensioned with a counterweight. The **U**-shaped bend in the transmission line allows for slack to compensate for wind and snow loads as well as making it possible to raise and lower the line for maintenance. The line is then routed up and over the post before being routed to the metal building that houses the shack. I used ½-inch electrical conduit for each wall feed-through.

I relied on electrical putty to seal the hole on the outside of the electrical conduit to keep bugs out. The spreader shown was installed after the two wires were routed from the inside of the building. **C** clamps held the two spreader parts together while the adhesive set. Two splice/reducers below the **C** clamps connect the two sections of the line. This also allows a disconnect for lightning protection when the system is not in use. The passage through the wall with metal exterior has a negligible effect on the open wire line.

Rope clips come with **U** bolts.

An aluminum **U** channel connects the assembly to a rope.

The rope runs through a pulley and is then tensioned with a counterweight seen against the post in the foreground. Half-inch electrical conduit comprises the shack wall feed-throughs.

A collection of counterweights made from concrete poured inside 3-inch standard ABS plastic plumbing pipes.

However, care must be taken to eliminate possible arc-over. Insulated wire and electrical conduit are more than adequate for this concern.

Homebrew Counterweights

My go-to method for making counterweights is to start with 2½-foot lengths of 3-inch-diameter standard ABS plastic plumbing pipe. I use a single piece of rebar and stand it up on a board and pour a few inches of dry concrete mix into it, then pour a few ounces of water on top of the dry concrete. I keep repeating until the pipe is filled. I recommend pouring the dry concrete into a bucket and using a small container to gradually pour the dry concrete into the pipe. This will prevent concrete from spilling all over the work site and making a mess.

I place the rebar into the wet concrete when it can stand alone. Let the weight dry for 2 or 3 days in the vertical position with no disturbance. My last step is to weld a ⅜-inch eye bolt to the rebar to accept the rope. Of course, it's also possible to bend rebar into a **U** shape and avoid the hook. Finally, spray-paint the exposed metal with rust-preventing paint.

The 2½-foot weights weigh about 20 pounds. The two outside the container are 3⅓ feet long and weigh about 30 pounds. I use the heavier weights to suspend the heavier transmission line and wire antennas longer than about 200 feet. The plastic skin on the weight is softer than raw concrete or steel, which is friendlier to the tree trunk when the weight sways back and forth in the wind.

I installed a 75-foot run up to a small wooden shed that will house antenna relays and tuning circuits. It will also be the switching and control point for the final 200-foot run to the top of the property (next year). The final installation will have about 400 feet of open wire line to the very top of the property.

Bob Zavrel, W7SX, has been licensed since 1966 and has held an Amateur Extra class license since 1974. He is a life member of ARRL and has been an ARRL technical advisor since 1984. He is a Senior Member of the IEEE, with 40 years experience in RF engineering and engineering management. Bob holds a BS in physics from the University of Oregon and is a adjunct professor of electrical engineering at Gonzaga University. He wrote the ARRL publication *Antenna Physics: An Introduction*, authored over 70 technical publications, and has been awarded six patents. He has earned DXCC Honor Roll for both mixed and CW modes. Bob currently operates an engineering consulting business specializing in RF technology and applications. You can reach him at **w7sx@arrl.net**.

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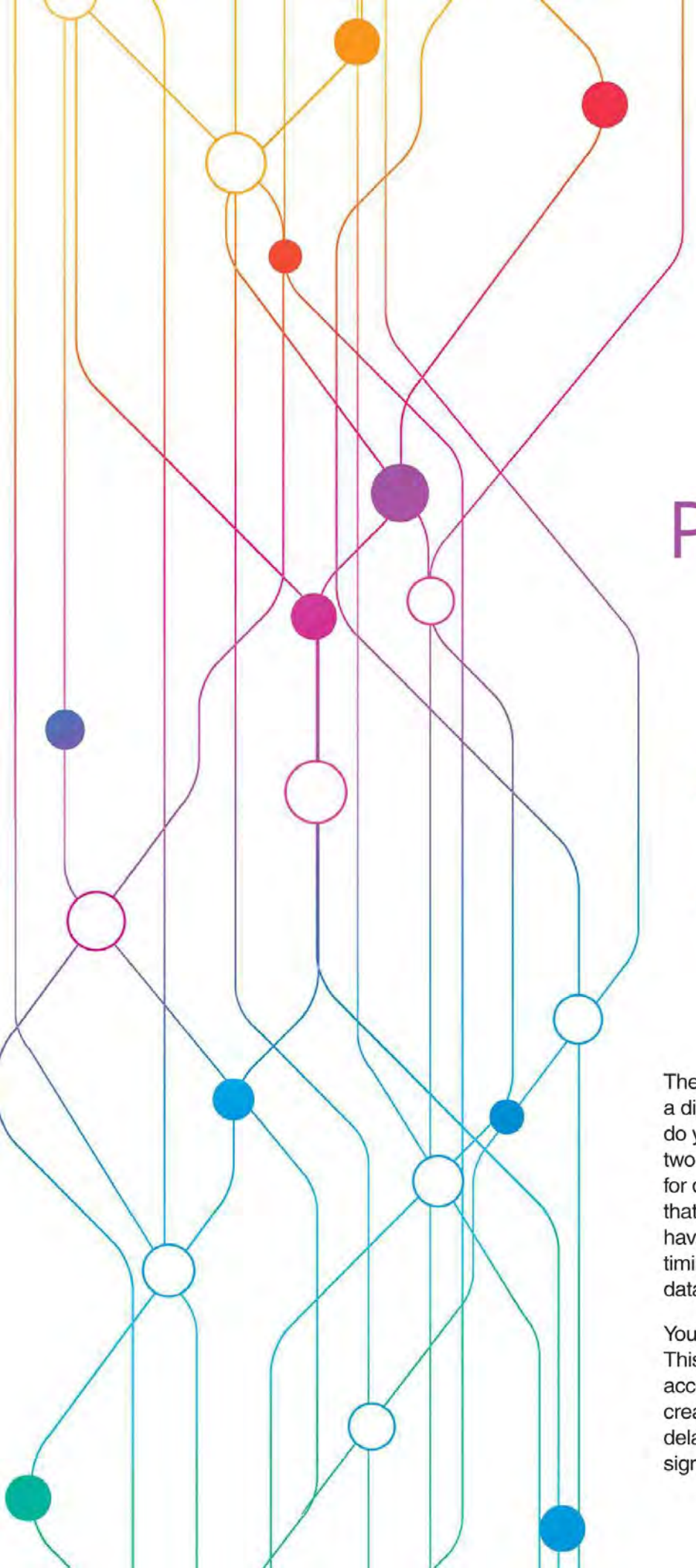


Using Integrated Circuits to Add Propagation Delays

In digital circuits, you sometimes need to delay one signal with respect to another. Here's how.

Klaus Spies, WB9YBM

There are certain applications where delaying a digital signal is desired. For instance, what do you do when you have a circuit requiring two inputs — such as an "enable" command for downstream circuitry, and a data input for that same downstream circuitry — but all you have is a single signal? In most cases, the timing of the "enable" signal with respect to the data is critical for proper circuit operation.

You need a way to turn one signal into two. This is not as strange as it may sound. You can accomplish this by splitting off the main signal, creating a secondary signal, and then providing delay for either the main signal or the secondary signal. There are a few simple ways to do this.

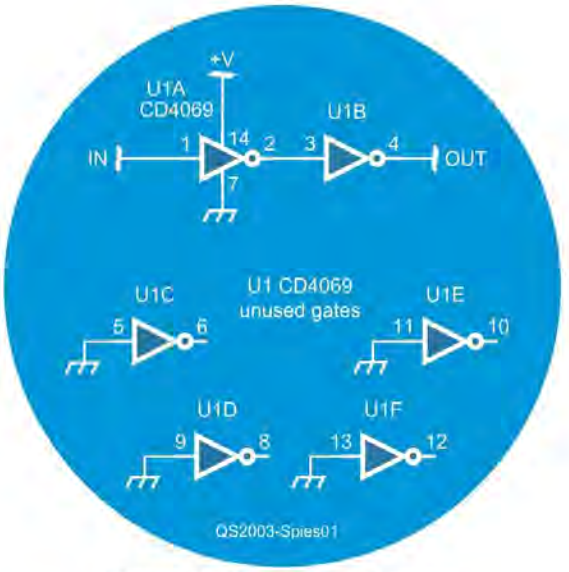


Figure 1 — Using cascaded gates to increase propagation delay.

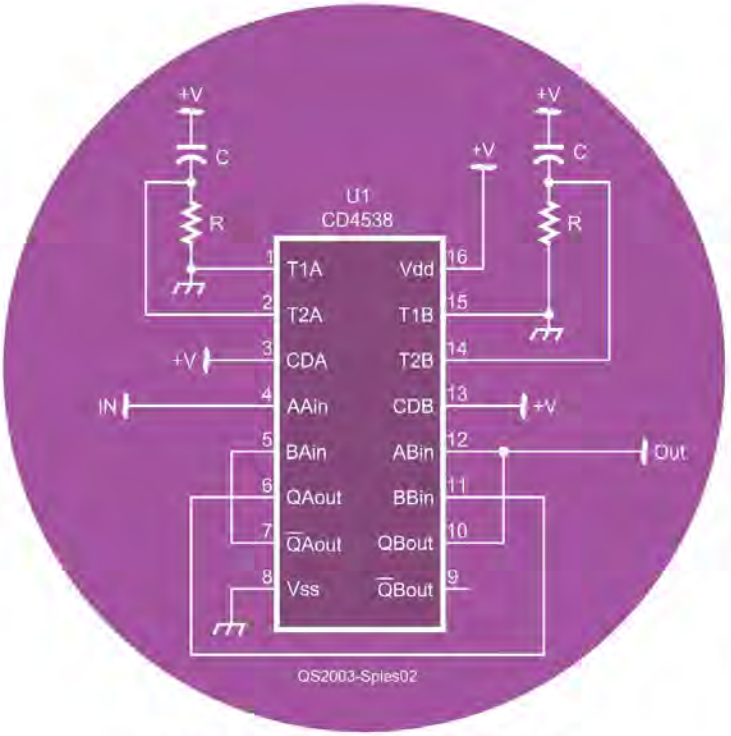


Figure 2 — Using monostable oscillators to add propagation delay.

Figure 1 shows the easiest approach: chaining two or more integrated circuits together. Each gate adds a certain amount of delay, which can be found in the data sheet of the integrated circuit used. As an example, the CD4069/MC14069 hex inverter shown in Figure 1 has a per-gate typical propagation delay of 25 – 55 nanoseconds, depending on power supply voltage. Note that when using inverters, an even quantity of gates is necessary to preserve the same logic sense, and the output has the same pulse length as the input.

Figure 3 — A diagram of propagation delay timing.

For An Even Longer Delay

If longer pulse lengths or longer delays are needed, as is sometimes the case for noise reduction or switch debouncing circuits, a monostable oscillator can be used. Figure 2 is an example of a CD4538/MC14538 dual oscillator. If we want to delay the rising edge of a signal, we'll have the first monostable trigger from the leading edge. Using the formula T = RC to calculate the time constant, we can set the length of the time delay needed. The second monostable is triggered from the lagging edge of the first monostable after the first delay time has elapsed. As the time constants are predetermined by T = RC, they do not exactly duplicate the incoming signal. However, because our concern is generating leading edge time delay of a signal, an exact duplicate is not necessary in this application. Figure 3 shows a timing diagram of this approach.

There are more sophisticated ways of delaying signals that may be more appropriate in critical designs. However, for many ham-related projects, the simple approaches shown here are effective and inexpensive.

Klaus Spies, WB9YBM, became interested in radio in the 1970s by listening to shortwave and VHF/UHF. He received his first ham license in 1975 and currently holds a General-class license. Klaus has also earned almost every license issued by the FCC, a few of which don't even exist anymore. On the professional side, Klaus's career has followed a technical path as a research and development electronics engineering technician, starting at Motorola and progressing through several other companies. Currently, he is self-employed as an electronic circuit designer and author, developing circuits from concept through manuscripts for several technical journals, including *QST*, *CQ*, *73*, *Nuts and Volts*, *RADCOM*, and others. You can reach Klaus at **wb9ybm1@yahoo.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

"Leaky" Antenna Switches

When switching between equipment and antennas, it is important to consider the RF isolation your switch provides.

Ellwood (Woody) Brem, K3YV

Any ham who has two or more antennas has probably considered using an antenna switch, which allows you to switch your radio from one antenna to another without having to connect and reconnect antenna cables each time you change antennas. Some modern radios have built-in antenna switches, and quite a few antenna tuners do as well. And then there are basic standalone switches and even remote outdoor switches.

Besides switching multiple antennas to one radio, antenna switches can also be used to switch multiple radios to one antenna. The problem with switching radios is keeping the RF output signal of the transmitting radio from causing damage to the off-line radio or other equipment (such as a receive preamplifier), which can be damaged if too much power leaks through the switch. Every switch has some degree of leakage between the selected port and the unselected port(s). So, RF from a radio transmitting through one port will leak through to the switched-off port. To safeguard your gear from inadvertent damage, the antenna switch must provide a high degree of isolation between its switched-on port and its switched-off ports.

How Much Leakage is Too Much?

How much power can a receiver accept without damage? Unfortunately, many manufacturers don't specify a maximum input signal level. Radio manufacturers who do specify a safe input power level generally limit the maximum to between +10 and +20 dBm. I have always used +10 dBm, to be on the conservative side. That translates into 0.01 W or 1.0 V peak RF voltage in a 50 Ω system. So, considering +10 dBm as our limit of maximum input power, how much isolation is required in our antenna switch?

The maximum output power allowed by the FCC for amateur stations is 1,500 W, which is +61.76 dBm. If we are to limit the input power of our offline radio to +10 dBm, then we need at least 51.76 dB of isolation. That's a lot of isolation.

The MFJ-2703 switch.

Generally, a switch will have higher port-to-port isolation at HF than VHF, with the isolation getting progressively less as the frequency increases. Unfortunately, not all antenna switch manufacturers specify their isolation. Among those that do, some manufacturers specify their switch isolation to be greater than 50 dB at HF, while others specify greater than 70 dB isolation. We have shown that nearly 52 dB of isolation is necessary when running 1,500 W. Therefore, switches with 50 dB of isolation are extremely marginal. Switches with 70 dB of

Table 1
Measured Isolation in dB Between Switch Ports

	Isolation (dB)					
Frequency (MHz)	Pos 1		Pos 2		Pos 3	
	Port 2	Port 3	Port 1	Port 3	Port 1	Port 2
3.0	129	122	129	129	121	128
4.0	129	116	127	125	115	127
5.0	129	111	125	117	110	124
7.5	122	102	117	111	103	116
10.0	117	97	109	104	97	110
12.5	112	93	105	99	93	106
15.0	112	91	107	96	90	105
17.5	114	88	105	93	87	103
20.0	113	86	102	91	85	101
22.5	109	84	100	92	84	99
25.0	107	82	96	90	82	98
27.5	109	81	94	88	80	96
30.0	108	80	92	86	79	92

isolation ensure a good safety margin for high-power operation.

Measuring Isolation

While verification of switch isolation is desirable, measuring switch isolation is not easy. Most hams do not have test equipment sensitive enough to measure 50 to 70 dB of attenuation. Fortunately, I had access to highly sensitive laboratory test equipment, which allowed me to achieve accurate isolation readings.

I recently purchased an MFJ-2703 three-way antenna switch. Its planned use is to select between my main station (which can run up to 1,500 W) and my backup equipment (which can run up to 600 W). The third port on this switch is available for a future radio. MFJ specifies the Port-1 to Port-2 isolation to be greater than 70 dB at HF, but they do not specify isolation for the third port.

I measured the port-to-port isolation using an RF signal generator and a spectrum analyzer, as shown in Figure 1. Specifically, I connected an RF signal generator to the common port of the switch. The switched-in port (through-port) was terminated in 50 Ω. A laboratory-grade spectrum analyzer was connected to each of the two unselected ports, one port at a time. The amount of leakage measured from each unselected port was read directly on the spectrum analyzer and recorded. The difference in signal level, expressed in dB, between the input signal and the leakage signal is the port-to-port isolation. Each port in turn was selected as the switched-in port, while leakage levels were measured in each un-selected port. Thirteen individual frequencies between 3 and 30 MHz were measured. Table 1 shows the tabulated measured isolation.

My measurements show that the MFJ-2703 switch has its highest isolation between Ports 1 and 2. The highest measured isolation was 129 dB from 3 MHz up to 5 MHz, with the least isolation being 108 dB at 30 MHz. Note that this confirms our expectation of more leakage at higher frequencies. The MFJ-2703 exceeds our minimum isolation requirement by more than 50 dB, which gives us an excellent safety margin at 1,500 W. Even the worst-case isolation from Port 3 to Port 1 of 79 dB at 30 MHz provides a margin of 27 dB at 1,500 W. Other switches could be measured using the same technique.

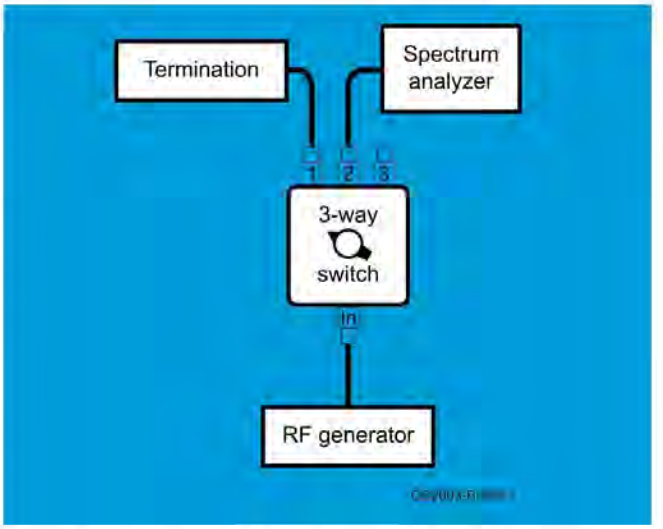


Figure 1 — A diagram of the author's isolation test setup, which consists of a Keysight N5173B RF generator, a Keysight N901A spectrum analyzer, a 50 Ω termination, and the MFJ-2703 three-way switch.

Grounded Ports

Many antenna switches, such as the MFJ-2703, have their unselected ports shorted to ground. Port-grounding antenna switches offer protection from electric discharges due to rain or snow static, as the offline radio's input is always at ground potential. Anyone who has had arcing across their antenna connectors on a snowy winter day will appreciate this. In my case, I use a shorted PL-259 connector on the unused third port of my MFJ-2703, which I select when I am off the air. That ensures that the antenna feed line and my two transceiver antenna ports are all grounded when I'm not on the air. This is a great side benefit of an external (stand-alone) antenna switch.

Antenna switches offer convenience in station operation and protection from static discharge. As with all antenna systems, keep the voltage standing-wave ratio (VSWR) low, don't exceed the power limitation of your feed line or antenna, and make sure your antenna switch has enough isolation to protect your equipment.

Woody Brem, K3YV, has been a ham for 57 years. He is an RF/microwave engineer and holds a Master's degree in Electrical Engineering from Penn State University. Woody lives in Spring Mills, Pennsylvania with his wife, Sharon Gaisler, N3SG, and their two cats, Rho and Theta, the Gamma sisters (named after the complex reflection coefficient of transmission line theory). You can reach Woody at **eeb3568@gmail.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Batteries for the Elecraft KX3 and Other Low-Power Radios

How to choose batteries for portable operation.

Eliot Mayer, W1MJ

I assembled an Elecraft KX3 low-power (QRP) transceiver from the no-solder kit, and have enjoyed operating portable with it, from ARRL Field Day on a mountaintop in New Hampshire to the shores of Easter Island as CEØY/W1MJ (see the sidebar, "Must-Haves for Portable Operation," for some tips). Choosing a battery for these field operations with the KX3 was not obvious. Choices for other QRP radios are similar, but there are differences too.

Battery Types Considered

The KX3 has an internal battery case for eight AA cells, but I did not find this a very useful feature. I was also concerned about having this case pressing directly against the delicate surface-mount components in the radio. Elecraft said that there were no reported reliability issues caused by this arrangement. Even so, I removed the holder and turned it into a spare external battery pack that holds non-rechargeable, long shelf life lithium cells. It serves as a backup to my rechargeable batteries.

The selection of rechargeable batteries for a QRP radio depends mainly on weight and budget considerations. The radio specifications and intended usage also factor in. I carried the radio up the 4,000-foot Galehead Mountain in New Hampshire at age 60, so weight was a big factor for me. Also, because I transmit only with the traditional QRP upper limit of 5 W, I can use lower voltages than the KX3 requires for operation at 10 – 15 W. Check the manual about power supply requirements for other radios.

Table 1 summarizes the most common rechargeable battery options. Lithium-ion batteries are very lightweight, but they are available only in multiples of the 3.7 V cell voltage. An 11.1 V battery works well for a KX3 at 5 W operation.

Must-Haves for Portable Operation

For battery-powered portable operations, be sure to bring spare batteries, even if they don't match the capacity of your primary source. You may just need enough energy to finish a contact and end your session.

Many hams log contacts using computers, but bringing along laptops, smartphones, or GPS devices means more battery consumption. To keep things simple, always take along a compass and map for navigating, and use a pen and paper for logging contacts.

Weatherproof carrying cases for equipment can help protect expensive gear. To protect yourself, bring bug spray, sunscreen, a first aid kit, and water on every portable excursion.

Table 1
Summary of Rechargeable Battery Types

Battery Type	Cost	Weight	Comment
14.8 V lithium ion	High	Lowest	Requires voltage reducing circuit
11.1 V lithium ion	High	Lowest	Limits KX3 to 5 W output
12.8 V lithium iron phosphate ($LiFePO_4$)	High	Low	Good overall choice; author's favorite
12 V sealed lead acid	Low	High	Best choice on a budget

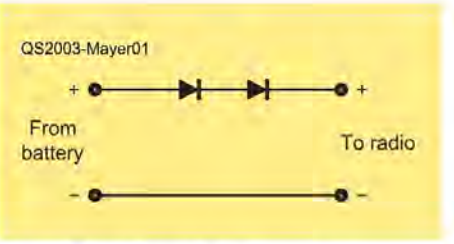


Figure 1 — A simple battery voltage reducer.

A 14.8 V lithium-ion battery can run the KX3 at its full 15 W output. However, its voltage when fully charged exceeds the KX3 15 V power supply limit, so a voltage reducer or regulator is needed. Two series diodes (see Figure 1) rated at least 2 A and 25 V in the power cables should suffice. 1N5402 diodes (Digi-Key 1N5402RLGOSCT-ND) are appropriate for this task.

Phil Salas, AD5X, developed a circuit with two such diodes and a relay that bypasses the diodes when the battery voltage is below 15 V (see his article in the April 2015 issue of *QST* for more information). I also found a solution using an efficient switching regulator in KR7W's SOTA Adventure Blog (**www.kr7w-sota.blogspot.com/2013/01/qrp-ops-battery-power-fyi.html**). However, looking at the flat spot from 13 V to 15 V in Figure 2, it appears that the AD5X and KR7W circuits might not extend KX3 operating time per charge beyond that of the simple two-diode approach. More KX3 power consumption data is available on the **www.arrl.org/qst-in-depth** web page.

Supply Current vs. Supply Voltage

Battery capacity is measured in ampere-hours (Ah). A 5 Ah battery should nominally deliver 1 A for 5 hours. For more on battery capacity, see Rick Palm's, K1CE, "Public Service" column in the March 2015 issue of *QST*. When selecting a battery for your radio, consider that its power supply current may vary with battery voltage.

The current-voltage relationship goes in opposite directions on different QRP radios. According to measurements by Clinton Turner, KA7OEI, the Yaesu FT-817 draws more current as the power supply voltage increases (**www.ka7oei.com/ft817_pwr.html**). My own measurements show that the KX3 current *decreases* as the voltage increases. For 5 W operation, the KX3 supply voltage can range from 9 to 15 V dc, and power supply current is significantly lower at 15 V than at 9 V. This is probably because efficient switching voltage regulators are used for some of the radio circuitry. Switchers draw approximately the same power independent of the input voltage, so current goes down as voltage goes up.

Figure 2 shows my KX3 measurements with the radio set for 5 W transmit power on 14.060 MHz. The backlight, preamp, and receiver isolation amp (RX ISO) were all turned off — they would consume an additional 53 mA when on. I calculated the average power at 25% transmit duty cycle; this duty cycle is based on active Field Day CW operation using full-break-in keying, where the radio switches to receive mode between every dit and dah. In the semi-break-in mode, the radio uses more than double the power between dits and dahs than it uses during receive.

Battery and Charger Suppliers

I strongly recommend buying battery packs that include protection against over-charging, over-discharging, and over-current. One example is the $LiFePO_4$ 18650 battery, rated at 12.8 V and 4,500 mAh, available from **www.batteryspace.com**

UN38.3 Battery Certification

Occasionally, you'll read stories about lithium batteries in laptop computers, cell phones, and other devices suddenly overheating and bursting into flames. These incidents are rare, but they are destructive and even potentially life threatening when they occur.

A number of years ago, the United Nations established strict standards concerning transportation safety when it comes to lithium metal and lithium ion cells and batteries. These standards have been adopted by most nations.

For a battery design to receive a UN38.3 certification, it must pass a series of rigorous tests that subject the battery to:

- Low air pressures
- Extremes of heat and cold
- Powerful vibrations
- Severe impacts
- External short circuits
- Crushing
- Overcharges
- Forced discharges

Failure to pass any of these tests means that a battery cannot be shipped by air, rail, boat, or vehicle, or be used to power a device that might be transported in this fashion.

and other battery and battery accessory suppliers, like Bioenno Power (**www.bioennopower.com**) and Powerwerx (**powerwerx.com/batteries-chargers**).

The battery is UN38.3 certified, which means that the battery is safe to transport (see the sidebar, "UN38.3 Battery Certification"). It is wise to purchase batteries with this designation. It is also a good idea to purchase a matching charger, as recommended by the seller. Clicking "Related Products" on the Battery Space web page for the 12.8 V battery shows such a charger. Other chargers, such as solar chargers, are also okay as long as you follow the charging specifications for the battery.

Not surprisingly, it is easier to find batteries online these days than in physical stores. An online search will show many more suppliers than the few I have mentioned, but physical battery stores do still exist. For example, check the store locator for Batteries + Bulbs to see if one is in your area (**www.batteriesplus.com**).

It is also possible to assemble your own battery pack from components, just like my friend Jacques Patry,

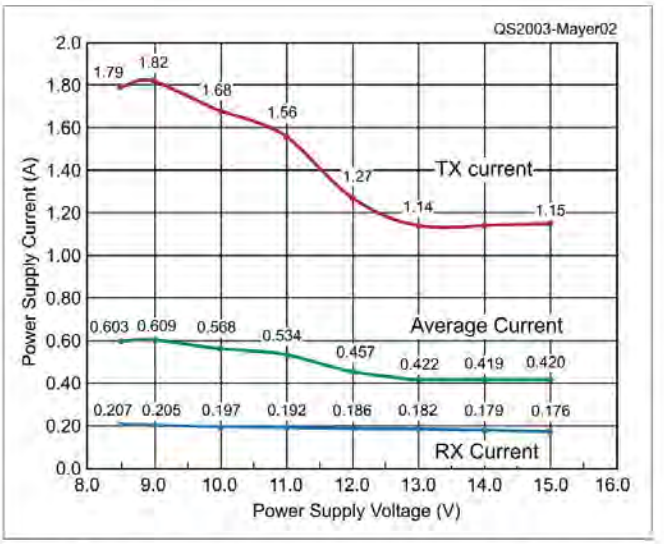


Figure 2 — Power supply current versus voltage for the KX3. Other QRP radios have very different current versus voltage behavior.

WD1I, does. He shops on sites like **www.aliexpress.com** and **www.banggood.com**. Jacques mentions that you should be sure to include a battery maintenance system (BMS) board. It prevents over-charge and over-discharge. It also equalizes the charge on each cell and maintains equilibrium.

Summary

Battery selection for your QRP radio depends primarily upon your budget, and on the importance of weight for your planned usage. Sealed lead-acid batteries are the best choice for hams on a budget. Lithium iron phosphate ($LiFePO_4$) batteries are much lighter, but are more expensive. Lithium-ion batteries are priced similar to lithium iron phosphate batteries, and are even lighter, but the available voltages are not always a good match for the radio. I hope this helps you select a battery for your QRP radio.

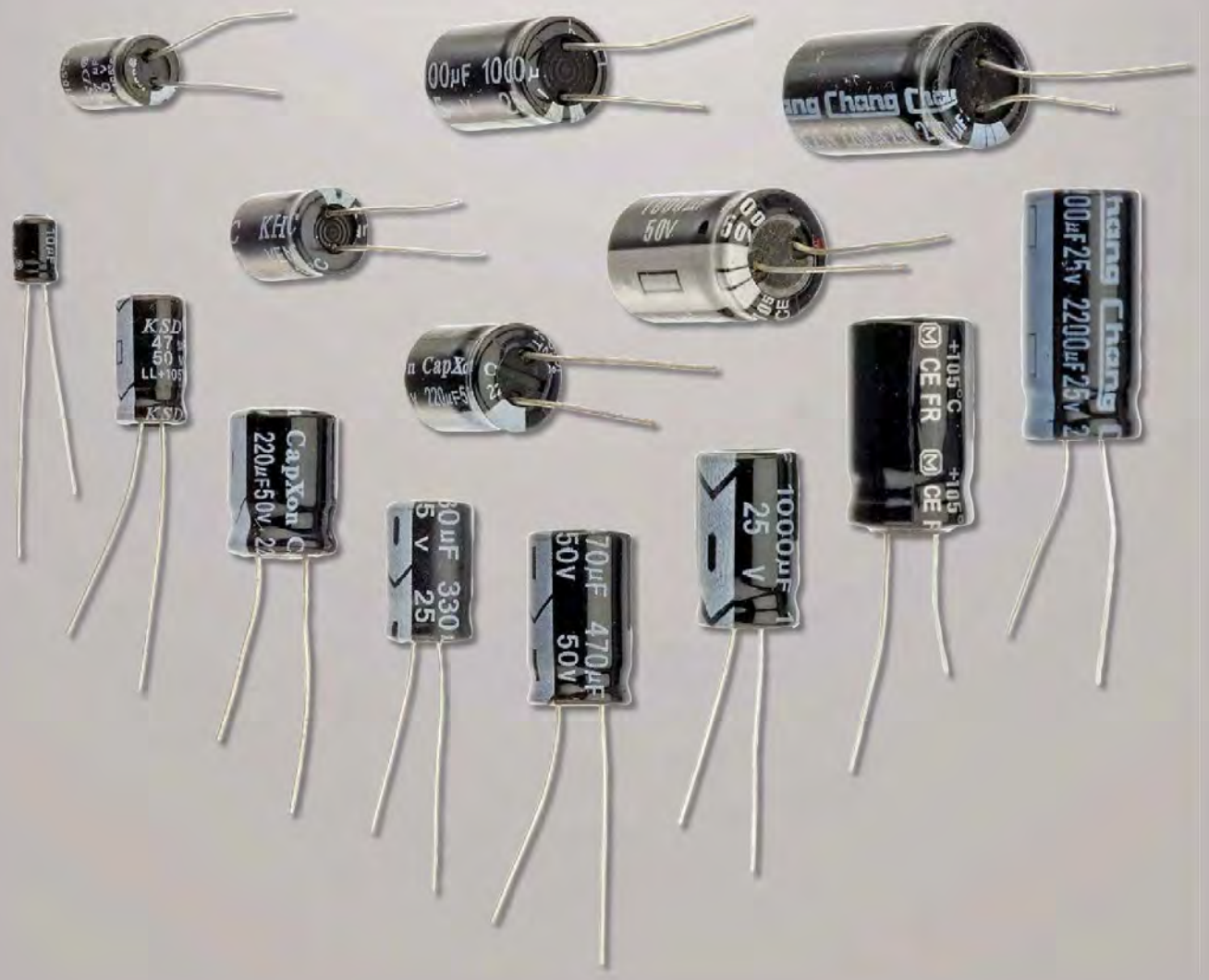
Eliot Mayer, W1MJ, is an electrical engineer with a BSEE from the University of Massachusetts at Amherst and an MSE in management from the Gordon Institute of Tufts University. He works on the design and manufacturing of medical imaging equipment at Analogic in Peabody, Massachusetts. Eliot was first licensed as a Novice in 1970 with the call sign WN1MYK. His ham radio activities include QRP holiday-style DXpeditions, operating a K3 radio from his condo home station, guest operating at the high-power stations of fellow Yankee Clipper Contest Club (YCCC) members, and 2-meter FM on his daily commute. His favorite ham event is ARRL Field Day. His radio operations can be found at **www.w1mj.com**. You can reach Eliot at **eliotmayer@yahoo.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Close Up

Electrolytic Capacitors

Even in the era of surface-mount devices, electrolytic capacitors with through-hole wire connections are still widely used. Electrolytics are polarized capacitors with positive and negative leads separated by a dielectric. As some kit builders learn the hard way, installing an electrolytic capacitor “backwards” can be problematic, to say the least!



Mark J. Wilson, K1RO, k1ro@arrl.org

Product Review

Xiegu G90 HF Transceiver

Reviewed by Phil Salas, AD5X
ad5x@arrl.net

Xiegu's G90 HF transceiver fills the void between QRP (usually 5 W output) and 100 W radios. Let's take a look at this interesting product, which is distributed and supported by MFJ Enterprises in the US.

Overview

The Xiegu G90 is built on a downconverting software-defined radio (SDR) platform using a 24-bit 48 kb/s sampling analog-to-digital/digital-to-analog converter. A limited bandwidth signal is mixed down directly to baseband, where the signal processing occurs — it is a direct conversion transceiver. (See the *QST* in Depth web page, **www.arrl.org/qst-in-depth**, for more information.) The G90 transmits on the 160- through 10-meter ham bands and has a general-coverage receiver that tunes continuously from 500 kHz to 30 MHz. Transmit power is adjustable from 1 to 20 W, and operating modes include SSB, CW, and AM, as well as digital modes using an external computer.

The G90 includes many features typically found on desktop transceivers, such as split-frequency operation, a built-in SWR bridge, an automatic antenna tuner, a receiver preamp and attenuator, a digital noise blanker, a CW decoder, and variable band-pass audio filters. Additionally, there is a built-in CW keyer and a speech processor for the SSB operator. A 1.8-inch color TFT LCD screen simultaneously displays everything necessary during operation, and it even includes a 48 kHz wide spectrum display and a waterfall display. There is an excellent-sounding top-mounted speaker.

Bottom Line

With 20 W of output power and a wide-range internal auto tuner, the Xiegu G90 is a capable transceiver in a well-thought-out, compact package that will interest the portable operator.

Interfaces and Controls

The G90 looks like a miniature version of my Icom IC-706MKIIG 100 W transceiver. The front panel can even be remotely mounted using the included 1-meter-long DB9 extension cable! And while the G90 is loaded with controls and interface connectors, everything is easily accessible.

Figures 1 and 2 show the various connectors. On the rear, you'll find a standard SO-239 antenna connector, along with 3.5-millimeter stereo jacks for **KEY** (manual, paddle, or external keyer) and **COM** (to update firmware in the main unit). There's also an **I/Q** output for external I/Q channel processing or display (an add-on panadapter had been announced, but was not available when this was written). The eight-pin mini-DIN **ACC** jack is for amplifier interfacing and external audio in/out for digital modes. Finally, there is a mini-Tamiya power connector and a ground connection.

Figure 1 — The Xeigu G90 rear panel.

Figure 2 — Connectors on the sides of the G90, near the front panel. See text for details.

On the left side of the front panel, there are two 3.5-millimeter stereo jacks for headphone and front-panel firmware updates. The microphone plugs into an RJ45 jack on the right side of the front panel. On the top of the radio are up/down buttons for band and mode selection.

The front panel includes 13 pushbuttons, a volume knob, a multifunction knob, and a tuning knob. The knobs have multiple uses, which I'll cover later. All buttons are clearly marked and have a good tactile feel, and most of these buttons provide additional functions depending on whether they are tapped, pushed and held, or accessed after pressing the **FUNC** button. Again — more on this later. There is a yellow LED that flashes in sync with incoming CW when you have the signal properly tuned in, a yellow LED that lights when the **FUNC** button is pressed, and an LED that lights green on receive and red on transmit. The multifunction keypad on the included microphone also permits access to all of the radio's features.

Figure 3 — The G90 display.

Power Requirements

The G90 requires an external power source of 10.5 to 16.5 V dc. Although the specifications state that the power source must be capable of 8 A maximum current, actual measurements show that less than 5 A are required at maximum power. For portable operation, I prefer lithium polymer (LiPo) batteries due to their low cost and high energy capacity versus size and weight, but a 4S LiPo battery has a fully charged voltage of 16.8 V dc. I asked Xiegu about this, and they stated that the G90 will operate fine up to 17 V dc, and that a 4S LiPo battery is a good choice for portable operation.

A 10 A fused #16 AWG cable with a mini-Tamiya power connector-to-tinned bare wire ends is included with the radio. I added an Anderson PowerPole connector to the wire ends, as that is my standard dc interface. The LiPo batteries for airsoft guns use the same mini-Tamiya connector as the G90, and compatible #14 AWG power cables are readily available from airsoft suppliers. However, be careful if you purchase a prewired airsoft connector, as these cables normally have the red and black power wires reversed from the wires in the G90 power connector.

Firmware Updates and Documentation

A 3.5-millimeter-to-USB cable is provided for firmware updates as well as computer interfacing. You must separately update the main unit and the front-panel firmware. Updating the firmware requires numerous steps, as detailed in the G90 *User Manual*. While this is a somewhat tedious process, it is not difficult.

Xiegu has been very responsive to user inputs with respect to bug fixes and feature updates. Because of these frequent changes, the documentation supplied with G90 transceivers is almost certainly outdated. MFJ maintains the latest G90 firmware and documentation on their website. There is also a very active G90 user group at **groups.io/g/XieguG90** that maintains the latest firmware and documentation in the **FILES** section. The G90 user group is also a great resource for tips and getting answers to your questions.

Some Additional Testing

Table 1 shows the results of testing in the ARRL Lab, with additional comments in the "Lab Notes" sidebar. In addition to the ARRL Lab tests, I did detailed testing on transmit power and current versus the transmit power setting and found that the power setting is reasonably accurate. It is typically within ½ W. At 13.8 V dc input, the required current ranges from about 2 A at 1 W output, to 4 – 4.5 A at full output — much lower than the 8 A maximum current specification. See the *QST* in Depth web page for a table of test results at various power levels on a number of amateur bands.

Next, I tested the internal automatic antenna tuner (ATU). There is no information given on the ATU's capability, so these tests were run to determine its resistive matching range and loss using a precision

Table 1
Xiegu G90, Serial Number X0419350537

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: 0.5 – 30 MHz; transmit, 160 – 10 meter amateur bands.	As specified. On 60 meters, transmit is 5.3305 – 5.405 MHz.
Power requirement: transmit, 8 A maximum; receive, 500 mA maximum, at 10.5 – 16.5 V dc.	At 13.8 V dc: Transmit, 4.4 A typical at maximum RF output, 2.1 A at minimum RF output. Receive, no signal, maximum volume and lights, 558 mA; minimum lights, 540 mA. Power off, 0 mA.
Modes of operation: CW, AM, SSB.	As specified.
Receiver	**Receiver Dynamic Testing**
SSB/CW sensitivity: 1.8 – 2 MHz, 0.35 µV; 2 – 30 MHz, 0.25 µV.	Noise floor (MDS), 500 Hz bandwidth: *Preamp off* / *Preamp on* 1.0 MHz –128 dBm / –136 dBm 3.5 MHz –131 dBm / –138 dBm 14 MHz –132 dBm / –138 dBm 28 MHz –134 dBm / –139 dBm
Noise figure: Not specified.	Preamp off/on: 14 MHz, 17/8 dB.
AM sensitivity: 0.5 – 2 MHz, 10 µV; 2 – 30 MHz, 2 µV.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz bandwidth: *Preamp off* / *Preamp on* 1.0 MHz 4.73 µV / 2.04 µV 3.8 MHz 2.82 µV / 1.49 µV 29 MHz 2.40 µV / 1.66 µV
ADC overload level: Not specified.	Preamp off/on: –8/–17 dBm.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth: *20 kHz offset* / *5/2 kHz offset* *Preamp off/on* / *Preamp off* 3.5 MHz 123/121 dB / 123/120 dB 14 MHz 121/118 dB / 121/108 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset (500 Hz BW): 100/84/84 dB.

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth)

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/off	20 kHz	–131 dBm –97 dBm	–46 dBm –23 dBm	97 dB
14 MHz/off	20 kHz	–132 dBm –97 dBm	–37 dBm –25 dBm	95 dB
14 MHz/on	20 kHz	–138 dBm –97 dBm	–47 dBm –14 dBm	91 dB
14 MHz/off	5 kHz	–132 dBm –97 dBm	–41 dBm –29 dBm	91 dB
14 MHz/off	2 kHz	–132 dBm –97 dBm	–42 dBm –29 dBm	90 dB

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	Preamp off/on, 14 MHz, +39/+47 dBm; 21 MHz, +29/+27 dBm.
IF/audio response: Not specified.	Range at –6 dB points:* CW (500 Hz BW): 495 – 933 Hz; Equivalent Rectangular BW: 442 Hz; USB (2.4 kHz BW): 266 – 2,750 Hz; LSB (2.4 kHz BW): 266 – 2,750 Hz; AM (6 kHz BW): 92 – 3,160 Hz.
Receive processing delay time: Not specified.	8 ms.
Transmitter	**Transmitter Dynamic Testing**
RF power output: 20 W (CW/SSB); 5 W (AM carrier), at 13.8 V dc.	CW/SSB, typically 1.4 – 19 W; AM, 1.4 – 19 W at 13.8 V dc.
RF power output at minimum specified operating voltage: Not specified.	At 10.5 V dc: 1.4 – 15.2 W typical.
Spurious-signal and harmonic suppression: 45 dB.	HF, typically 68 dB; 55 dB (worst case, 160 meters); 50 MHz, 68 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 19 W PEP: –32/–46/–50/–58 dB (HF typical) –29/–43/–44/–48 dB (worst case, 20 m) At 10 W RF output: –34/–39/–45/–56 dB (14 MHz)
CW keyer speed range: Not specified.	5.3 to 57 WPM; iambic mode A and B.
CW keying characteristics: Not specified.	See Figures 4 and 5.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, SSB, 400 ms; CW, 132 ms.
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 60 ms.
Receive processing delay time: Not specified.	8 ms.
Transmit phase noise: Not specified.	See Figure 6.

Size (height, width, depth): 2.0 × 5.5 × 9.8 inches (including protrusions). Weight, 3.6 pounds.

Second-order intercept points were determined using S-5 reference.

*Default values; bandwidth is adjustable.

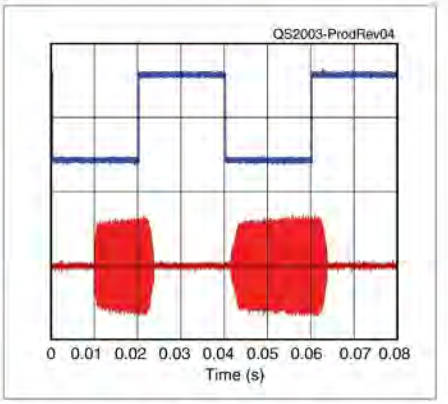


Figure 4 — CW keying waveform for the Xiegu G90 showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 19 W output on the 14 MHz band.

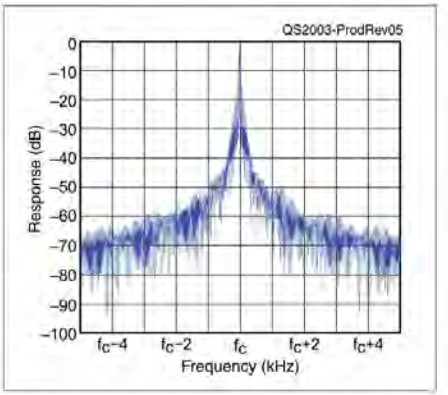


Figure 5 — Spectral display of the Xiegu G90 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 19 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

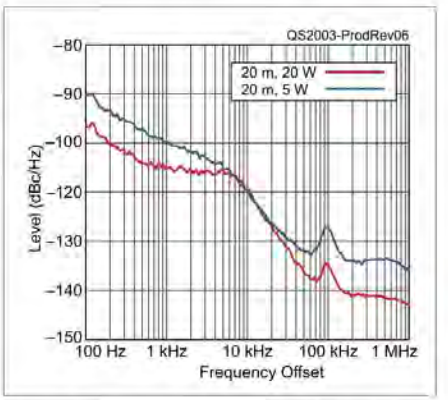


Figure 6 — Spectral display of the Xiegu G90 transmitter output during phase-noise testing. Power output is 19 W on the 14 MHz band (red trace) and 5 W on the 14 MHz band (blue trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier. The reference level is –80 dBc/Hz, and the vertical scale is 10 dB per division.

setup. The full test results are available on the *QST* in Depth web page. From 160 to 40 meters, the loss was negligible (less than 5%) with high-impedance loads up to 400 Ω (8:1 SWR), but was higher with low-impedance loads. On 20 to 10 meters, loss was negligible with most loads from 5 to 200 Ω and just 12 to 14% at 400 Ω.

I also performed open/short circuit testing. I found no instances where the G90 ATU would match an open or short. This implies that the G90 ATU has reasonably low internal losses — obviously a desirable characteristic.

I did find one obscure problem with the G90's antenna tuner operation. On 17 meters, when some reactive loads were tuned to 1:1 with the internal auto tuner, I observed an unstable transmit power variation between about 12 to 20 W. I first found this when using my 43-foot vertical, but then I was able to duplicate it on the bench. Xiegu reported that they had found this issue with some G90 transceivers, and that the problem is resolved in any units shipped after June 2019. MFJ verified the problem, and also verified that recent G90 transceivers no longer have this issue.

Lab Notes: Xiegu G90 HF Transceiver

Bob Allison, ARRL Laboratory Test Engineer

The Xiegu G90 does a fairly good job of handling strong adjacent signals with 108 dB of blocking dynamic range (BDR) at 2 kHz signal spacing. Its two-tone, third-order IMD dynamic range is 90 dB — more than enough for a modest antenna system. Reciprocal mixing dynamic range (RMDR), at 84 dB, is reasonable compared to other portable transceivers we have tested.

The G90 is certainly sensitive when using CW and SSB modes, but it could do a bit better on AM (we like to see 1 µV or better AM sensitivity). The second-order intercept point is lower than average, especially at 21 MHz. This means that it's possible to hear unwanted mixing products when propagation conditions are good and shortwave radio signals are strong. For example, two strong broadcast stations transmitting at 6 and 15 MHz may cause a signal generated inside the G90 to appear at 21 MHz. Audio from both broadcast stations are mixed together into one (false) AM signal.

The G90's transmitter exceeds FCC requirements for harmonic and spurious emission levels. Closer to the intended transmitted signal, CW sidebands are higher than average but will not bother stations on nearby frequencies unless signals are strong. Transmit IMD is higher than we would like to see, but is in line with other low-power transceivers we have tested. Transmit phase noise close to the transmitted signal is also higher than we'd like to see. It is for these reasons that we do not recommend using a power amplifier with this transceiver.

Operating the G90

First, let me state that the display is amazing. As you can see in Figure 3, even though the display is quite small, it is easy to read and provides a tremendous amount of simultaneous information, even showing the signal level in dBm on the spectrum display. I checked the signal level reading against my Elecraft XG3 signal generator, and the G90 displayed levels are quite accurate. The S-meter readings are also quite accurate at reasonable signal levels, dropping 6 dB per S-unit when going from –73 dBm to –107 dBm (S-3 to S-9). The S-meter reads about 20 dB high at a very high –33 dBm signal level (S-9 + 60 dB). Detailed test results are shown in a table on the *QST* in Depth web page.

While the G90 controls and buttons are self-explanatory when used for typical operation, it is worth mentioning some of the controls that have dual or triple functions. The volume control, when tapped, redirects the audio from the internal speaker to the headphone jack and reduces the audio level accordingly. Note that the G90 will not directly drive an external speaker. A powered external speaker will be necessary. An AlexMic G90 is available, which has an amplified speaker built into the mic (see **www.alexloop.com**). This is very similar to the AlexMic for the KX3 and KX2 reviewed in the February 2018 issue of *QST*, but with the correct connectors for the G90.

The multifunction knob, located below the power button, defaults to 100 kHz tuning steps for moving quickly around the bands. A long press on this knob brings up other default functions that can be selected instead — squelch level, power output, keying speed, and FFT scale (band scope display gain). The main tuning knob, when tapped, changes the tuning step from 10 to 100 to 1,000 Hz. The five buttons below the display are clearly marked, and their secondary functions (when the **FUNC** button is tapped) are also clearly marked.

To engage the internal auto tuner, tap the **TUNE** button once. Then press and hold **TUNE** to start the tuning process. When tuning is complete, the radio automatically reverts to receive mode. To disengage the tuner, tap **TUNE** again. Tuning normally takes less than 1 second, and the last tuning solution is remembered for each band.

Tapping the **POW** button once permits you to adjust transmit power with the main tuning knob. Tap the **POW** button a second time and you can set the SWR level that will begin folding back transmit power. A long press of the **POW** button enables an SWR sweep. The default scan width is 150 kHz centered around your receive frequency, but you can also select 300, 450, 600, and 750 kHz sweep ranges. One complete scan takes about 5 seconds, and scanning continues until you press **QUIT**. And finally, if you first tap the **FUNC** button and then tap the **POW** button, you can adjust your microphone gain or select the audio input (microphone or external audio).

Tapping the **LOCK** button sequentially adjusts the display brightness. A long press of the **LOCK** button locks the radio, and another long press will unlock it. Pressing **FUNC** and then tapping **LOCK** permits you to adjust the spectrum display gain (FFT level).

CW Operation

The internal keyer speed range is approximately 5 to 55 WPM. Because I adjust keying speed frequently, I set the multifunction knob default to keying speed. You

can select either CW or CWR (reverse) depending on interference conditions. The default CW filter bandwidth is 500 Hz, but you can narrow this all the way down to 50 Hz by pressing the **FUNC F-L** and **FUNC F-H** buttons.

Break-in delay can be set from 0 to 1 second in 100 millisecond increments. However, the delay will never be less than 100 milliseconds because of the SDR signal processing latency, and so the G90 is not capable of full-break-in (QSK) operation. At this time, there are no CW memories. Unlike the X5105 reviewed in the April 2019 issue of *QST*, I found no evidence of key clicks in the G90. The waveform is shaped well enough to avoid this problem.

Clicking from the transmit/receive relay is audible but not objectionable. In the ARRL Lab, Bob Allison, WB1GCM, noted that there are no rubber feet on the bottom of the G90's case, and mechanical coupling between the transceiver and a hard tabletop surface transfers the sound of the relay to the table, making it louder. Adding rubber feet to the bottom cover will reduce this effect.

SSB Operation

SSB operation was almost exhilarating for me. While I can easily make CW contacts at the 5 W QRP level, SSB contacts are much more difficult. However, at the 20 W power level, phone contacts are quite easy to make. The G20 includes a speech compressor which is enabled via a button below the display. And while the compression level is currently not adjustable, the fixed setting works very well.

The default SSB receive filter bandwidth is 2.4 kHz, but you can adjust this using the **FUNC F-L** and **F-H** keys as in the CW mode. I found that the default receive audio passband response was very pleasant to listen to. There is currently no transmit audio equalizer, but the transmit audio is excellent according to reports received during contacts on the air.

Digital Modes

The G90 can be operated with a computer and sound card for FT8, RTTY, PSK, or any of the other popular digital modes. You will need to build or buy an eight-pin mini-DIN radio-to-computer sound card interface cable, or purchase the Xiegu CE-19 Expansion Interface. The interface connections are well documented in the G90 *User Manual.*

Final Thoughts

I found the G90 to be a very enjoyable transceiver to operate. The 20 W transmitter power makes a very big difference when compared to the typical 5 W QRP transceiver, especially for SSB operation. Because of the SDR architecture, we can expect to see more capabilities and features added over time. My only desire would be to have a built-in tilt stand, and maybe an option to give up 160 meters if 6 meters could be included instead. Finally, the Xiegu G90 has a 2-year warranty when purchased through MFJ Enterprises.

Manufacturer: Xiegu Technology Co. Ltd. Distributed and supported in the US by MFJ Enterprises, 300 Industrial Park Rd., Starkville, MS 39759, **www.mfjenterprises.com**. Price: $449.95. CE-19 Expansion Interface, $29.95.

SOTABEAMS Wolfwave Audio Processor

Reviewed by Paul Danzer, N1II
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The Wolfwave Advanced Audio Processor from SOTABEAMS can add selectivity to an existing receiver or transceiver, and it offers a number of other audio processing features as well. It connects to the headphone jack or speaker output and provides processed audio that can be used with headphones or a speaker.

Bottom Line

The Wolfwave Advanced Audio Processor offers a number of ways to add filters, noise reduction, and other features to receivers without those amenities.

Overview

The block diagram for the Wolfwave is simple — audio is fed to an analog-to-digital (A/D) converter, and then it goes to a microprocessor. The processed signal then goes to a digital-to-analog (D/A) converter and then to an audio amplifier connected to the output jacks. The 4 × 3 × 1 inch package is powered by either a USB cable (cable included, without USB power supply) or an external 5.5 to 18 V dc supply. Current draw is approximately 60 mA. We used a 12 V dc wall cube supply.

The Wolfwave is controlled by firmware, which can be updated online using the USB cable. If the USB cable is used to power the unit, the 5 V available in a standard USB connection is fine for headphone use, but it will provide lower speaker output than the 1 W available when using an external power supply of 7 V or more.

The right side panel of the enclosure has a 3.5-millimeter stereo headphone jack and a 3.5-millimeter speaker jack, along with the 2.1-millimeter coaxial dc power receptacle (center pin positive). The left side has the 3.5-millimeter stereo audio input jack and a micro-USB connector. There is also a pushbutton labeled **FIRMWARE** for use during the update process.

One important word of caution — neither side of the speaker can be grounded. The audio amplifier has both output leads floating, and grounding one of them may result in damage to the amplifier. This is important to note if you are using a matching speaker to an older transceiver where one speaker lead is typically grounded to the metal enclosure.

Received audio spectrum and menu commands are shown on a monochrome front-panel display that measures approximately 1⅛ × 11/16 inches. A two-color LED is mounted just to the upper left of the display and lights green when a CW signal is detected at the center of the passband. There is no power on/off switch, so you will have to control this function externally.

There are three pushbuttons on the front panel. **MENU** picks the general function you want to select or adjust. **MODE** lets you adjust the selected function and access submenus if available. **HELP** brings up context sensitive information, just as a right click does on many PC applications.

On the bottom of the panel are the audio **VOLUME** control and one labeled **MULTI-USE**. **MULTI-USE** helps select operating mode and menu values (more on this control later).

Using the Controls

I found that there was a bit of a learning curve to be able to rapidly make selections and adjustments using the menus and submenus. The Wolfwave unit has repetitive selection patterns, so with practice, these selections can be made quickly and accurately.

The initial display shows an audio spectrum (100 – 2,700 Hz) with a vertical dotted line in the center representing the filter center frequency. The default is that the band-pass filter is enabled, bandwidth is 2,400 Hz, and the center frequency is 1,500 Hz. To show the general pattern of operation, let's set up a CW filter:

- Rotating **MULTI-USE** (we'll just call it **MULTI**) changes the filter bandwidth in the range of 50 Hz to 5,000 Hz in steps of 10 Hz to 100 Hz depending on bandwidth. You can adjust the width at any time. The display has three ranges, with upper limits of 1,400, 2,700, or 5,000 Hz. It adjusts automatically to the narrowest range that fits the upper edge of the selected passband.
- Press **MULTI** and you will see **CENTRE 1500 Hz** (the default center frequency). Adjust the center frequency by rotating **MULTI** until it matches your preferred CW tone (I like 750 or 800 Hz). Figure 7 shows a 600 Hz filter. You can adjust the filter parameters every time you turn the unit on, store your favorite settings, or select from several preconfigured filters.

To access and adjust other Wolfwave features, the general pattern is:

Figure 7 — The Wolfwave set up for a 600 Hz CW filter with a center frequency of 650 Hz.

- Press **MENU** to bring up a list of functions. Scroll through this menu by rotating the **MULTI** control and then press the **MULTI** control to turn a function on and adjust it. As an example, select **NOISE REDUCTION**, and a press of **MULTI** will turn it on and display a sub-menu with several options (including an **ADVANCED** submenu with further options).
- Rotate **MULTI** to highlight the desired parameter, press **MULTI** to select the parameter, and again rotate **MULTI** to adjust the setting.
- Within each submenu, highlight the top line and press **MULTI** to go back to the previous menu.

Within the menu system, pressing **MULTI** and pressing **MODE** usually have the same effect. Pressing **MENU** brings you back to the top-level filter display without having to back out through multiple menu layers.

Testing the Modes and Features

Bypass Function

A long press of the **HELP** button turns off the processing functions. The label **BYP** will appear in the lower left corner. A second press turns processing back on.

Band-Pass Filter

On-the-air testing showed the filter was very sharp and as good as I wanted — as long as the LED on the panel showed green. In addition to experimenting with various SSB bandwidths, I tuned in a strong AM broadcast carrier (S-9 plus) to be just inside the filter passband. Then I slowly turned the transceiver VFO knob to move the carrier out of the filter passband. The carrier quickly dropped to just about S-0. With the tiniest change in transceiver tuning I could manage, the carrier switched between these two values — S-9 and annoying, to S-0 and barely audible.

The Wolfwave offers 14 memories to store band-pass filter settings. Four are preset — wide/narrow for CW and data, and wide/narrow for SSB. The rest are open for your selections, and you can designate a default power-on setting.

A recent firmware addition is **BANDSTOP FILTERING**, which allows the user to set up to 10 notches within the passband. The center frequency and width of each notch is adjustable, and the instructions suggest 100 Hz as the minimum usable width. This might be helpful to reduce unwanted signals within the passband, low-frequency hum, high-frequency hiss, or other irritants. When **BANDSTOP FILTERING** is enabled, any programmed notches are shown in the **BANDSTOP FILTERING** display.

Noise Reduction and Tone Reduction

I tested the **NOISE REDUCTION** function on 75 meters during July, with typical high summer noise levels. Coarse (5% steps) and fine (1% steps) adjustments are available (see Figure 8). I started with the noise reduction level at 50% while listening to my local club net one evening. That level brought minimal improvement. As I increased the setting toward 90%, the noise went down, but the digital artifacts increased (the underwater effect often heard with noise reduction systems). Weaker stations, which I could not really hear in the noise, were reduced to clipped snippets of sound. However, very strong stations became much more readable. At around 75%, the noise was reduced — but not to zero — and the moderately strong stations were easily understandable. For quieter band conditions, settings around 30% reduce the background noise without too many digital effects.

A submode of **NOISE REDUCTION** is **TONE REDUCTION**, where the Wolfwave automatically identifies and notches a steady tone. The **NOISE REDUCTION** mode must be on for **TONE REDUCTION** to work. I tried this function with AM broadcast carriers ranging from S-2 to well over S-9, and the tone was suppressed effectively. Some fuzziness was introduced when the tone was next to the edge of a sideband signal, but that is to be expected.

Hearing Loss Correction

The manufacturer describes this function as applying a gain curve that varies with frequency according to the international standard ISO 7029 (**www.iso.org/standard/42916.html**). From the main menu, select **HEARING LOSS COMP**, and then your gender and age.

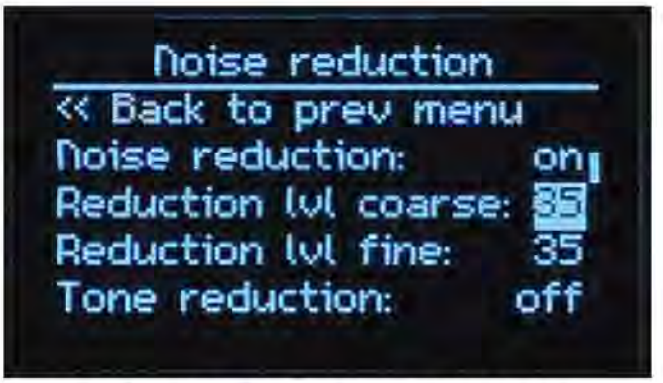

Figure 8 — Setting the Wolfwave noise reduction features.

Figure 9 — The Wolfwave Morse decoder screen.

I use hearing aids, so I was very interested in this mode. The instructions also note that if you do use hearing aids, this compensation will not replace the hearing aids. Generally speaking, **HEARING LOSS COMP** adds gain at higher audio frequencies. I removed my hearing aids and set the function for my gender and age. On CW, as expected, I heard no obvious difference because the tone of the CW note was not high (around 800 Hz). Similarly, I didn't hear a noticeable difference while listening on SSB with a filter bandwidth set to 2,300 Hz.

I set the upper limit of the filter bandwidth to 5,000 Hz and tuned in some music on a shortwave broadcast. There was definitely a difference in the high frequencies of the broadcast transmission, but because the bandwidth was limited to 5,000 Hz, I didn't hear a big difference. While this mode appears to work, I didn't find it too useful for typical ham radio modes, which have limited audio bandwidth.

More useful for some operators is the left-right balance control included in a recent firmware update. Accessed from the **OUTPUT SETTINGS** menu, this feature allows increasing the audio level in one ear or the other in ½ dB steps to compensate for differences in hearing.

Morse Code Decoder

Decoded text appears on the display's left side and a audio spectrum scope on the right (see Figure 9). The received signal to be decoded must be centered in the spectrum scope. You can do that by tuning your receiver to the correct pitch, or by turning the **MULTI** knob to match the Wolfwave to the received pitch.

The Wolfwave automatically adjusts to the received CW speed. The default setting allows CW speeds from 5 to 40 WPM, but you can change the limits from 1 to 100 WPM. The detection threshold can be changed as well, which helps with false decodes from noise.

I found the decoder to be very accepting of off-frequency tuning — the pitch just has to be close to the incoming signal. In addition to showing decoded text, dots and dashes are shown at the bottom of the screen and the measured code speed in words per minute on the top left corner. If the band is noisy, try raising the decoder threshold from its factory setting of 3 dB to perhaps 8 or 10 dB.

CW Regen

CW regeneration is a function that I have not seen for a long time. Many years ago, the National Company included a function called *Select-O-Jet* in several of its receivers. The circuit gave positive feedback on a selected frequency, and in the presence of noise or other signals, the selected tones would be boosted by the function.

In the Wolfwave, this experimental function detects the dits and dahs in the received signal and regenerates the CW signal with a clean sine wave and no noise. The CW tone to be regenerated must be in the center of the passband, and the trigger level point can be adjusted from 1 to 30 dB. The output (regenerated) tone can be set to be identical to the input CW tone or offset from it. With a stereo headset, you can listen to the received signal in one ear and the regenerated CW tone in the other.

For the regenerator to work, I had to carefully set the band-pass center frequency to the CW tone I use, and to carefully limit the input signal to the green LED range. The CW regenerator works well, but tuning is critical. Any attempt to change the receiver frequency by a tiny amount almost always resulted in loss of copy, requiring shutting the regenerator off and resetting the receive frequency.

Audio Test Generator

Under **UTILITIES** on the main menu, there is a selection to generate tones. Turning this on brings up an audio generator with the output selections of sine wave, triangle wave, square wave, and two-tone. Each of these can be set to a selected amplitude and frequency.

Support and Firmware Updates

The Wolfwave package does not include a printed manual, but detailed information about setup and operation may be found on the SOTABEAMS website, as well as a website dedicated to this product (**www.wolfwave.co.uk**). In addition to written instructions, there are tutorials and links to helpful videos.

SOTABEAMS offers accessories and replacement cables for the Wolfwave. One that may be useful is an audio ground loop isolator, which can reduce or eliminate hum from ground loops. This isolator plugs in between your transceiver and the filter, breaking the ground loop.

Firmware updates may be downloaded, along with Windows software and drivers needed for the process. The Wolfwave website offers well-illustrated, step-by-step instructions, as well as a video demonstrating the update process. New firmware with added features was released several times during the review period, so it's a good idea to check periodically for updates.

Manufacturer: SOTABEAMS, Macclesfield, United Kingdom; **www.sotabeams.co.uk** or **www.wolfwave.co.uk**. Distributed in the US and Canada by DX Engineering, 1200 Southeast Ave., Tallmadge, OH 44278; **www.dxengineering.com**. Price: $275.99.

Inexpensive Antenna System Tuning Indicators

Reviewed by Paul Danzer, N1II
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We looked at three inexpensive kits intended to simplify the sometimes-tedious process of adjusting an antenna or antenna tuner for a match that the transmitter can handle. The measuring circuit used in all three kits is a modified Wheatstone bridge. More information on the circuits may be found on the *QST* in Depth web page (**www.arrl.org/qst-in-depth**).

Table 2
Feature Comparison

	QRP Guys	HecKits	TennaDipper II
3 – 30 MHz range	Y	Y	Y
Counter function	N	Y	N
Signal generator output	N	Y	Y
Prepared case	N	Y	N
9 V battery needed	N	Y	Y
50 Ω test load supplied	N	Y*	Y*
Filter for signal generator	N/A	Y	Y
10 MHz counter time base	N/A	Y	Y

*The HecKits load is built into a BNC connector. The TennaDipper II includes a 49.9 Ω resistor.

Bottom Line

All three units reviewed here can help you to adjust an antenna or antenna tuner for minimum SWR by adjusting for minimum brightness on an LED. They are small, light, simple to use, and are well suited for portable operation.

QRPGuys LED Tuning Indicator

The LED Tuning Indicator from QRPGuys is the simplest and least expensive kit here. Designed to be used with a QRP transmitter (5 W CW or 10 W PEP maximum), this 1⅝ × 1¼ inch board is placed between the transmitter and antenna tuner or antenna (see Figure 10). The input and output BNC connectors mount directly on the board. Keep transmissions short while using the tuning indicator to find a match, and if possible, reduce power until the antenna or tuner is adjusted to a low SWR.

Construction is straightforward with step-by-step, well-illustrated instructions. The polarity of diode D2 is critical and is shown clearly in the manual. The tuning indicator is designed so that the male BNC connector can mount right on your radio's BNC antenna jack, and the antenna feed line connects to the female BNC jack on the other side. The pin spacing is different for the two connectors, so you cannot interchange them.

A toroidal core is wound as an autotransformer with 25 turns, tapped at 5 turns. An LED shows reflected power — the brighter it lights, the greater the reflected power. The LED and the transformer can be mounted on either side of the board, with the LED facing forward (toward your radio) or on the other side of the board, visible from the back.

Figure 10 — The QRPGuys LED Tuning Indicator requires no external power source. The input (male) BNC connector is shown here on the component side of the board, with the output BNC connector, indicator LED, and **BYPASS** switch on the other side. The board is intended to mount directly on the antenna jack of the companion QRP transceiver.

The **TUNE/OPERATE** slide switch places the tuning indicator in the feed line path, or bypasses it for operation once tuning is finished. The assembly manual notes that with the switch in the **TUNE** position, the transmitter power is reduced by a factor of four at the output jack (for example, 1.25 W output with a 5 W transmitter). At full LED brilliance, the SWR is 4:1 or greater. The LED goes out at 1:1 SWR, and at half brilliance, the SWR is about 2:1. Note that this device offers no guidance on which way to adjust the antenna system for best match. If the SWR is high, some experimentation is required while watching for the LED to dim.

My 5 W QCX QRP transceiver had more than enough power to light the tuning LED, so it was clearly visible in bright daylight. This radio has the antenna BNC connector on the side of the case and is only 1⅝ inch high, so the tuning LED could have been mounted on either side of the board and been very visible.

The QRPGuys LED Tuning Indicator is an inexpensive, lightweight, and compact companion for a portable station without an SWR/power meter built into the transceiver or antenna tuner.

Manufacturer: QRPGuys, **qrpguys.com**. Price: $20 plus shipping.

HecKits 50 Ω Bridge/Frequency Counter

The HecKits bridge (see Figure 11) includes a frequency counter and generates a low-level signal from 3 to 30 MHz, so it can be used to adjust an antenna or antenna tuner without transmitting a signal. It's powered from a 9 V battery and fits in a precut 5½ × 2½ × 1 inch plastic box.

The parts to be assembled mount on a single PC board, which is connected to the pre-assembled display module by two ribbon cables (see Figure 12). The builder does have to solder the ribbon cables to the display board. The boards mount in the case with *very* small nuts, but a tiny nutdriver is supplied.

Assembly is straightforward. Although I found the written instructions in the assembly manual unclear in spots, the illustrations filled in the gaps. The transistors require bending the center lead away from the flat side to fit the mounting holes. Carefully check the LED to find its polarity. You have to wind a toroid core for the transformer. The winding instructions are very good, but you may want to do the five-turn winding before the 30-turn winding.

I widened the three switch holes in the case with a 5/16-inch drill to provide a bit more clearance for the switches with their caps in place. The on/off slide switch is on the left side. The BNC connector used for the feed line is on the top. The two blue pushbutton switches below the display are used to select the frequency counter or SWR indicator function. Both buttons have to be in the up position for the frequency counter, and both down for the SWR indicator. The LED under the left switch is the SWR indicator.

The black knob on the right side is the shaft of a 30-turn potentiometer to adjust the frequency. According to HecKits, the small knob shown in Figure 11 has been replaced by a larger, easier-to-use knob in kits that are currently shipping. Frequency coverage is in two segments (3 – 12 MHz and 11 – 30 MHz) and is set by the lower blue pushbutton. The frequency readout is a two-line, eight-digit LCD module. A small variable resistor on the circuit board adjusts the brightness.

To find the resonant frequency of an antenna system, connect the feed line to the BNC jack. Set the device to bridge mode and adjust the potentiometer until the LED extinguishes. At that point, the SWR is 1:1 and the frequency is shown on the display. Alternatively, set the HecKits bridge to the desired frequency and adjust the antenna or tuner until the LED goes out. The kit includes a 50 Ω dummy load mounted in a

BNC connector to make testing the bridge and understanding operation easier.

By noting an antenna's resonant frequency on the display, you can try lengthening the antenna if it is resonant higher than the desired frequency, or shorten the antenna if it is resonant below the desired frequency. Adjusting an antenna tuner will require some experimentation.

To use the device as a frequency counter, set both blue pushbuttons to the up position and connect the signal to be measured to the BNC jack. Be careful to keep the applied signal to less than 100 mV.

Figure 11 — The HecKits 50 Ω Bridge/Frequency Counter is mounted in a plastic case with a two-line by eight-character LCD.

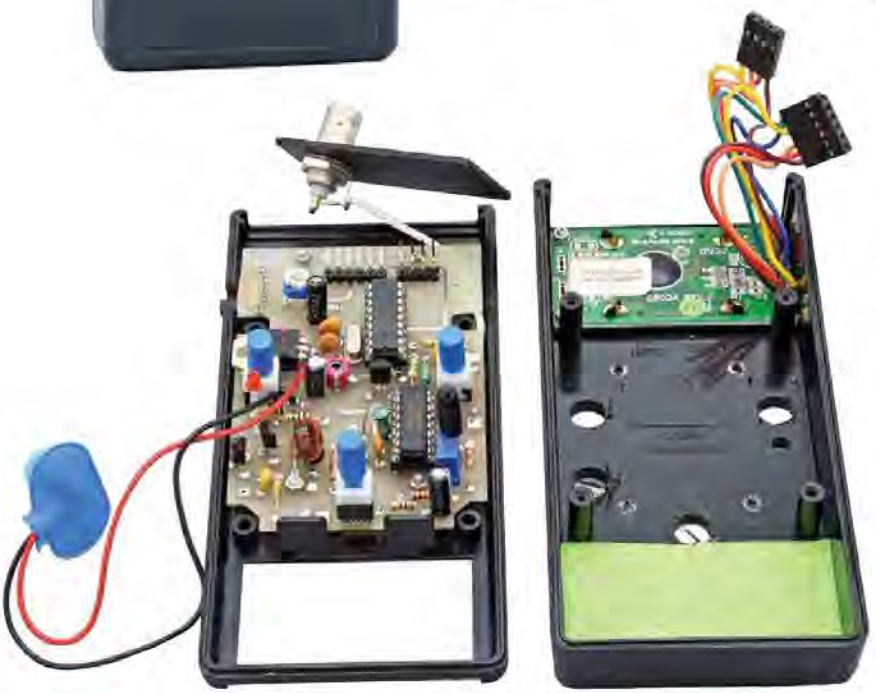


Figure 12 — The builder assembles the main HecKits PC board (on the left) and then connects it to the pre-assembled display board with two ribbon cables.

The test signal generated for the SWR indicator is a square wave that goes through a minimal filter. The output is not a single-frequency signal, but has harmonic components — generally odd harmonics for a square wave. While trying to find the resonant points of a triband Yagi, I found a number of resonances outside the ham bands. Some of these may have been due to the harmonics from the signal generator. Although it's not discussed in the manual, this device can be also used as a simple signal generator to see if a receiver is working.

Manufacturer: HecKits, 1302 Highland Dr., Cedar Park, TX 78613; **heckits.com**. Price: $85, plus $7.90 shipping.

Pacific Antenna TennaDipper II

The TennaDipper II is similar to the HecKits unit, but it uses an LED rather than LCD frequency display (see Figure 13). The case measures approximately 4½ × 2¾ × 1 inches. The four-digit frequency display shows through a window on the front panel, and like the other two units, the **MATCH** LED goes out when the connected load is close to 50 Ω (1:1 SWR).

For construction, you will need a pair of tweezers. A surface-mount IC is used as the voltage regulator. The simple instructions for mounting it are quite clear, but you will want to use something other than your finger to hold it in place while soldering.

All parts mount on a single PC board (see Figure 14). The board is very well made, with an excellent solder mask to prevent solder bridges. The pushbutton switches, **POWER** and **RANGE**, are not square. If a switch does not fit easily, rotate it 90 degrees. As with the HecKits unit, you will need to wind a toroid core for the transformer. I wound the five-turn segment first, leaving the rest of the toroid for the 30 turns. To make sure that the **MATCH** LED can be seen through the hole in the front panel, it must be raised off the board before soldering.

The kit includes a blank plastic enclosure and front-panel decal, but the builder needs to make the holes for the switches, BNC connector, and display. The PDF with the manual devotes six pages to the case preparation, including a page with a 1:1 template for the cutouts.

Figure 13 — The TennaDipper II in its plastic case. The controls are nicely labeled with a decal that covers the whole front panel. The builder needs to carefully cut and drill the case for the display and controls, as described in the text.

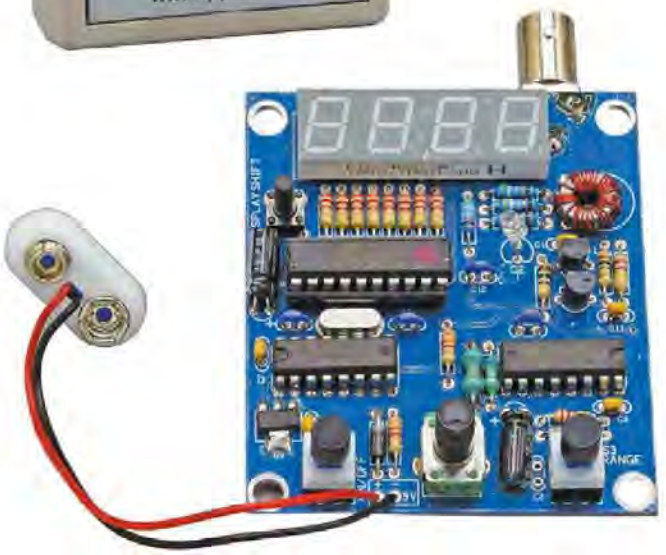


Figure 14 — The completed TennaDipper II board before mounting in the case. All components are mounted on the board, and the controls and display must carefully line up with cutouts in the case.

Before drilling the case, check the printed template carefully to make sure it is the correct size. The manual recommends using a step drill bit, and that worked well. You have to drill it perfectly to use the hole sizes shown on the template. I ended up making the holes one step larger than specified to get the buttons to operate smoothly.

More difficult was getting a good clean cut in the front panel decal, even with a Mazor knife with a fresh blade. The instructions recommend using a hole punch for best results.

Operation is similar to the HecKits unit, except the TennaDipper II does not function as a frequency counter. Connect the antenna or antenna tuner to the BNC connector. Frequency is controlled by the single-turn **TUNE** knob. The **RANGE** switch toggles between 3 – 11 MHz and 10 – 30 MHz. Pressing the **DISPLAY SHIFT** switch changes the display from frequency in MHz with 10 kHz resolution to frequency in kHz with 100 Hz resolution. The **MATCH** LED brightness dips as the SWR goes down, and it is very dim or completely out when the SWR is 1:1.

You can see whether to lengthen or shorten an antenna by noting its resonant frequency on the display. With an antenna tuner, you will need to experiment with different settings to find a good match.

As with the HecKits unit, you can use the TennaDipper II as a simple signal generator. The square wave output is somewhat rounded by two single-stage L filters, but the output does have harmonics.

Excepting for my difficulty preparing the case, I found the instructions and illustrations very clear, and the result is a very nicely designed and packaged instrument.

Manufacturer: Pacific Antenna, P.O. Box 10301, Fayetteville, AR 72703; **www.qrpkits.com**. Price: $45 plus shipping.

Explore the *QST* Product Review Archive
www.arrl.org/qst-product-review-and-short-takes-columns
Search reviews by year or issue of publication, or by manufacturer's name.

New Products

SOTABEAMS 2-Meter Band-Pass Filter

Designed and manufactured by SOTABEAMS, this band-pass filter is intended for use with handheld transceivers in areas with multiple transmitters, such as during hilltop or mountaintop operations. The filter offers SMA female connectors at both ends and is rated for 5 W at a 30% duty cycle and 2 W continuous. The filter bandwidth is 144 to 148 MHz with attenuation of up to 70 dB outside of the passband. $49.95; **www.sotabeams.co.uk**.

Joel R. Hallas, W1ZR, w1zr@arrl.org

The Doctor is In

A Satellite Antenna System Doesn't Need to Be Complicated

Q Allen, KF4JTR, asks: I want to build an antenna with a pattern pointed straight up to install at my house for use with satellites. I'm hoping to have a 160° view of the sky to get about 75% of the satellite's flight path while it's at its closest. I currently have a dual-band vertical with two obvious lobes — one just below 20° and the other at about 40°. The lobe at 40° works well (likely due to the satellite's distance plus the gain of the lobe), but makes it difficult to make a contact because of signal loss as the satellite passes in and out of my antenna's pattern. Suggestions would be appreciated.

Figure 1 — L.B. Cebik's, W4RNL, dual-Moxon phased array antennas for 2-meter and 70-centimeter satellite work.

A I think classic antenna guru L.B. Cebik, W4RNL, (SK) designed exactly the antenna you want in his article, "A Simple Fixed Antenna for VHF/UHF Satellite Work," from the August 2001 issue of *QST*.

This antenna consists of a pair of Moxon compact Yagis pointed skyward and driven 90° out of phase for an omnidirectional azimuth pattern for both 2 meters and 70 centimeters (it could be built for just one band if that's your only requirement). Figure 1 shows the configuration and the article discusses why it's superior to the more frequently encountered turnstile-connected dipoles over a reflecting screen.

As you get more involved in this, you may want to set up a V/UHF SSB station, if you don't have one already. If so, you will likely want to have Yagis for 2-meter and 70-centimeter SSB, CW, and digital modes. These will probably be horizontal rotatable antennas.

I mention this because in the late 1970s, I used horizontal Yagis in a brief encounter with amateur satellite operations. While many think that an azimuth-elevation rotator is needed to make a successful Yagi-based satellite antenna system, in my experience that's not the case (at least for satellites in low orbits). Horizontal gain antennas pointed toward the horizon at the proper azimuth as the satellite clears give you the highest gain at maximum range where needed. As the satellite goes overhead, the range is closer, and the Yagi needs little or no gain to maintain communication. With horizontally polarized Yagis for 2 meters and 70 centimeters, your antennas are also set up for terrestrial SSB and CW operation, which can be great fun, especially during V/UHF contests.

Q Barrie, VK2IBE, asks: I'm at a farm 60 miles south of my home in Sydney, Australia, where I've hosted amateur radio HF SSB and CW DX contests with plenty of space and a very low noise floor. We have no power lines here — we run on solar electricity from batteries and an inverter — and our nearest neighbor is about a mile away. We have been disappointed that despite having 500 W amplifiers (run at our legal limit of 400 W) on our three transceivers, we still often hear stations calling "CQ contest" that can't hear us. We assume it's a problem with our transmission lines or antenna systems, which we plan to assess (perhaps using *WSPR*). We'll also try raising and reorienting our horizontal dipole antennas and shifting to lower-loss coax. Do you have any other recommendations to improve our performance?

A Having a low noise floor offers a great advantage on receiving, however, the stations you hear so well may have a noise floor of S-4 to S-6, since they probably aren't as well situated as you are. Also, those calling CQ are often strong stations — they generally need to be strong to hold a frequency.

They are likely running the legal limit of 1,500 W PEP (6.7 dB over 400 W, more than 1 S-unit) output in the US, and running three- or four-element Yagis (perhaps 4 dBd, and a pair stacked, for the serious contest stations, another 3 dB).

Given that, they are transmitting with 11 – 14 dB, or around 2 S-units higher than you are. If they have an S-4 background noise (along with likely more local interference than you), it suggests that if all things are equal, you will need to hear them with an S-meter reading of 2 – 3 S-units higher than your background/receiver noise level to be about even in their receiver. The good news is that you can hear better than they can, but the bad news is that you need to transmit a stronger signal to overcome their noise and have a similar signal at their station.

Some of this is reasonably simple to improve on. Perhaps the easiest way is power level. Where I am, on most bands the power limit is specified as the transmitter output, but in some cases it is or has been specified as power transmitted by the antenna. If your rules are specified as power transmitted by the antenna, rather than out of the transmitter, you may be able to crank up your amplifier to 500 W for a 1 dB improvement (in a contest, every little bit helps).

You don't say how long your transmission lines are, or what type you are using. Long lossy runs make high SWR look low at the radio, meaning the line loss may be higher than you expect, based on your measurements at the radio. Having an antenna tuner at the radio will tend to mask this even more.

If your lines are longer than 50 feet, it's best to measure and record the SWR close to the antenna and determine the loss in the line based on that reading. If that's difficult, you can calculate the actual SWR at the antenna from the measurement at the radio using *TLW* (*Transmission Line for Windows*) software. For more information, see my article, "I Know What's Happening at the Shack — What's Happening at the Other End of my Feed Line?" from the February 2007 issue of *QST*.

If the real SWR is much higher than indicated at the radio end of the coax, you may have more loss than you think, and *TLW* will tell you the whole story. That's power that you don't need to waste.

That leaves antennas. If you have trees in appropriate places, or are willing to install masts, rhombics are a good solution at relatively low cost, especially if you're interested in a few directions. A single rhombic can cover 20 through 10 meters, or any other 2:1 frequency range with good performance. The use of a triplexer with filters can allow multi-transmitter stations to share a single multiband antenna on 20, 15, and 10 meters, for example, simultaneously. A Yagi at a good height can also do very well and offers more flexibility, but will likely cost more.

Or, keep in mind that you can only expect to work strong stations if they will have a high signal-to-noise ratio (SNR) at your end.

Q Joe, W3TTT, asks: I use 50 feet of coax cable for a 30-foot run from my multiband vertical to the antenna tuner, with the remaining length coiled in the shack. Does the inductance of this coil of 10 turns at a diameter of about 8 inches have an effect on my signal?

A No, the inductance of the coil does not reduce your signal. Your signal should be between the outside surface of the coax inner conductor and the inside surface of the shield. This is called a differential-mode signal. The inductance of the coil only applies to signals on the outside of the shield, where you don't want any signals. Such signals are called common-mode current and can cause problems if they make it to your equipment. The coil will be helpful in attenuating the common-mode current. It's even better to do the choking outside, to minimize coupling the common-mode signals into and from household appliances.

The extra coax will add some loss to your antenna system. Your multi-band vertical, if properly tuned, should have a low SWR on all its designed bands, so the loss should not be an issue. If you use RG-58 coax, with a 1:1 SWR, the loss in the 20 feet is about 0.6 dB at 30 MHz, and 0.24 dB if you're using RG-213 coax. At 14 MHz, it's 0.38 dB for RG-58 coax, and 0.15 dB for RG-213. While this is avoidable loss, it doesn't amount to much. Keep in mind that it takes 6 dB for a single S-unit on a calibrated receiver.

Do you have a question? Ask the Doctor! Send your questions to "The Doctor," ARRL, 225 Main St., Newington, CT 06111, or email your question to: **doctor@arrl.org**.

Also listen to the archives of episodes of the *ARRL The Doctor is In* podcast, sponsored by DX Engineering, on iTunes, Blubrry, Stitcher, or on the ARRL website at **www.arrl.org/doctor**.

Hints & Hacks

Testing LEDs, Mic Matters, Cleaning Connectors, and More

Testing LEDs Fast

Over the years, I've amassed about 1,000 LEDs from many sources, in all different colors and sizes. In the past, I tested them with a 12 V dc power supply, dropping resistor, and a few clip leads, which was a hassle.

I discovered a simpler, more convenient way to test them. All it takes is one quarter-sized, very thin, 3.6 V battery. I just slide the battery between the LED leads and the LED will either light up or it won't, indicating a bad LED or the need to flip the LED to the other polarity (see Figure 1). The speed and ease of this method has helped me test many LEDs without the need for a power supply, resistors, or clip leads. — *William Gerhold, K2WH,* **k2wh@optonline.net**

Mic Audio Solution

After years of trouble-free operation, one day my Kenwood MC-60A desk microphone wouldn't put out audio on my Kenwood TS-790E transceiver. The PTT switching worked perfectly, but there was no sound. It happened often when starting a transmission.

I experienced this problem on all combinations, between different transceivers and mics. A few other Kenwood users reported the same issues. Most of them were also heavy users and used the same sets. I did some more testing but could not find anything consistent.

Finally, I bought a new curled mic cable and immediately noticed the difference. I had no trouble at all. When I examined the new cable, I noticed the tight fitting of the cable plug.

This inspired me to work on my old curled cable plugs to improve the fitting. When I tried them out, I had no issues. Apparently, the spring-force of the female contacts in the cable plugs of the mic cable lose strength when used frequently. This leads to loss of audio during transmitting.

Bending the female contacts back to improve contact force helped only temporarily, so if you're experiencing this issue, a new plug is the real solution. — *Frank Laanen, PE1EWR,* **pe1ewr@zeelandnet.nl**

Figure 1 — Sliding a 3.6 V battery between the leads of an LED provides an easy method to test whether the LEDs are working. [William Gerhold, K2WH, photo]

Anti-Fly Hamfest Fliers

Have you ever placed your club's hamfest fliers on a table at a prior hamfest to promote your event, only to later find that your fliers have fallen onto the floor? At the Skyview Amateur Radio Society, we have eliminated this issue by binding our fliers into handy tear-off tablets.

Organize a batch of fliers into a neat stack and place them at the edge of a table. Then place something heavy (such as a power supply) at the top edge of the stack. Apply Elmer's glue with a small brush (or even your finger), coating the edge of the stack, as shown in Figure 2. Come back in a few hours and — *presto!* — you now have a tablet that will hold all the fliers in place until interested visitors pull them off. — *Bob Bastone, WC3O,* **wc3o@arrl.net**

Oil Burner Woes

I've operated SSB for years on the HF bands without interfering with our household electronics, but when I started using FT8 — a 100% duty cycle mode — my average output power was much higher. As a result, each time I transmitted, our oil burner would immediately shut down.

Figure 2 — Assemble a stack of fliers and align them at the edge of a table, using a heavy weight (a power supply in this example) to compress the paper and hold it in place. Using your finger, apply Elmer's glue along the entire edge of the stack. Allow to dry completely. [Bob Bastone, WC3O, photo]

Figure 3 — Winding about 14 turns of the thermostat line through a Type-43 ferrite core kept RF out of this oil burner control. [Dan Bowman, K1FEV, photo]

After some trial and error, I found the RF was getting into the burner control through the wire from the thermostat. Fortunately, the solution was straightforward. I purchased a Type-43 ferrite core and wound about 14 turns of the thermostat line through the core (see Figure 3). Problem solved! — *Dan Bowman, K1FEV,* **k1fev@arrl.net**

Clean that Connector!

DB9s and similar connectors can become intermittent due to the buildup of dirt and oxidization on the socket surfaces. An inexpensive and effective way to clean the sockets without having to remove the connector is to use a standard interdental cleaner with a tapered flexible wire brush (see Figure 4). These interdental brushes can be found at most drug stores.

Figure 4 — Sockets on small connectors, like the DB9 shown here, can be cleared of dirt and contaminants with an interdental brush. [Henry Boze, N4HB, photo]

To clean the contacts, add a small amount of electrical tuner cleaner or other suitable electronic cleaning solvent to the brush and clean out the plugs as required. The brush fibers should be periodically cleaned with a cloth or paper towel to remove any contamination. This process works well and has saved many female-type plugs, particularly those that are used in damp environments. — *Henry Boze, N4HB,* **henry.boze@gmail.com**

Yaesu MH-36B6JS Microphone Repair

I have a Yaesu FT-100 mobile radio. Recently, I had an issue with the coiled cable breaking at the strain-relief, so I bought and installed a replacement.

Everything worked fine until the push-to-talk (PTT) started acting up. It seemed as though I had to click the PTT several times (with the radio off, of course) in order to make the switch work. Then it would work intermittently, not engage at all, or disengage toward the end of a transmission. If I wiggled the PTT button, pushed it to one side while transmitting, or simply mashed it, it would work for a bit, but then become intermittent again.

Rather than buying a replacement microphone, I decided to take a homebrew approach. I found a great deal on microswitches on Amazon — a bag of 20 for just $7. These switches have side terminals where the original in the microphone had end terminals. This was not an issue because the terminals sit way above any surface-mount component.

The two bottom terminals are NO (normally open) terminals that close when the switch is activated. The top terminal is an NC (normally closed) terminal that opens when the switch is pressed. I trimmed the NC terminal off the new switch and soldered two new wires to the remaining terminals. I took the mounting screw out of the original switch and de-soldered the connecting wires from the printed circuit board.

Next, I soldered the wires from the new switch to the board. I then positioned the new switch over the mounting hole and screwed it in place. The original switch had a locator pin that kept it from rotating on the circuit board. The new switch does not, but it doesn't try to rotate when activating the PTT. Also, the end of the switch rests against one of the channel up/down switches, which gives it more support.

After re-installing the mic button, I re-assembled the mic and tested it during our weekly RACES/SKYWARN net. It works flawlessly. The microphone is back to "original" condition with a new cable and a new PTT switch, all for much less cost than expected. — *Doug Birky, KB8M,* **kb8m@arrl.net**

"Hints and Hacks" items have not been tested by *QST* or ARRL unless otherwise stated. Although we can't guarantee that a given hint will work for your situation, we make every effort to screen out harmful information. Send technical questions directly to the hint's author.

QST invites you to share your hints with fellow hams. Send them to "Attn: Hints and Hacks" at ARRL Headquarters, 225 Main St., Newington, CT 06111, or via email to **hh@arrl.org**. Please include your name, call sign, complete mailing address, daytime telephone number, and email address on all correspondence. Whether you are praising or criticizing an item, please send the author(s) a copy of your comments.

Steve Ford, WB8IMY, wb8imy@arrl.org

Eclectic Technology

Inexpensive Remote Operation with *NoMachine* and a Raspberry Pi

Harry Bloomberg, W3YJ, has come up with an easy, affordable approach to remote operating that will allow you to operate your station from almost anywhere. You can contact Harry at **w3yj@arrl.net**. *— Steve Ford, WB8IMY*

The first piece of my cost-effective remote solution is the Raspberry Pi. The Pi is a small single-board computer. It can run a popular distribution of the Linux operating system known as *Raspbian*. Raspberry Pis are inexpensive, starting at $35. A Raspberry Pi 4 with 4 GB of RAM can be purchased as a complete package with accessories for $99.

The next piece is *Fldigi* and *Flrig*, part of the Narrow Band Emergency Messaging Software (NBEMS) suite developed by Dave Freese, W1HKJ. Most hams associate NBEMS with emergency and public service operations. It is the standard communications package for many ARES groups. However, NBEMS also provides many features for recreational operation. *Fldigi* can function as a contest logger and CW keyer, for example. *Flrig* allows you to control a transceiver through a USB interface.

The final piece is *NoMachine* remote operating software. *NoMachine* is popular in the business world and uses the NX protocol to connect securely. *NoMachine* is free for personal use and will stream audio to and from the Raspberry Pi after running a few Linux commands. This gives you the ability to operate CW and SSB.

NoMachine makes clients for all major platforms including Windows, MacOS, iOS, and Android that can connect to the *NoMachine* server on the Raspberry Pi. *NoMachine* for all platforms along with installation instructions, documentation, and support is available from **www.nomachine.com**.

Putting It All Together

You can use a Raspberry Pi 3 in your remote station, but experience has shown that a Raspberry Pi 4 is more stable due to its improved CPU performance (see Figure 1).

Audio is processed on the Raspberry Pi by a package named *PulseAudio*, which acts as an audio server, sending and receiving streams of audio much as a web server sends and receives internet data. *NoMachine* interfaces to *PulseAudio*. A common commercial use for *NoMachine* is logging onto remote systems and streaming audio remotely to remote mics and speakers for Voice over Internet Protocol (VoIP) communications.

A detailed explanation of how to interface *NoMachine* with *PulseAudio* is beyond the scope of an article for *QST*. Please see the *NoMachine* remote operation overview and tech notes online at **www.w1hkj.com/W3YJ/Remote_Article.pdf** and **www.w1hkj.com/W3YJ/Remote_Tech_Notes.pdf**.

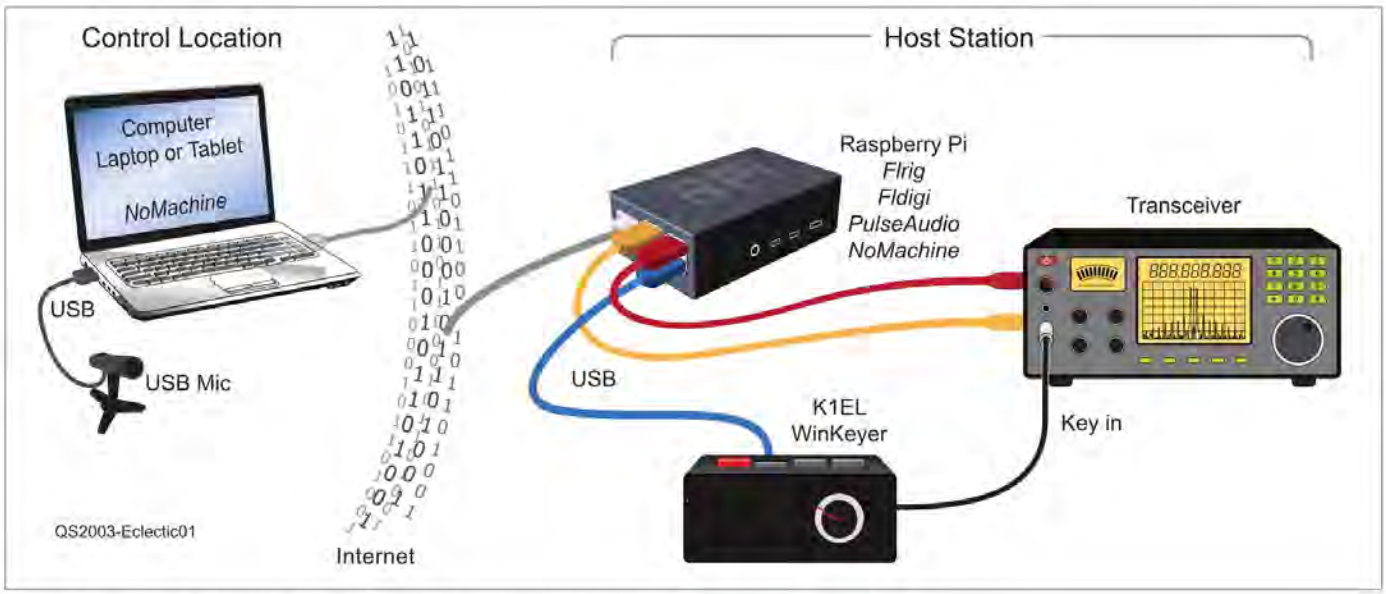


Figure 1 — A block diagram of Harry's remote station control system.

A Grid DXpedition in the Upper Peninsula

A recently licensed ham organizes an activation of a remote grid square in Michigan.

The K8B team, from left to right: Dan Brandner, N9DJB; Matt Okeson-Harlow, NM9O; Barry Arneson, K8SD; Thomas Baden, AC9BJ, and Troy Faulkner, KB9AZZ.

Sunset on Friday night after setup. Troy, KB9AZZ, is at the base of the mast, with visitors viewing on left.

Dan Brandner, N9DJB

As a new radio amateur, first licensed in August 2017, I always thought that large DXpeditions were too expensive and not feasible for the average ham, so I was searching for something closer to home, and at a reasonable cost. I was excited when I heard about the 2018 ARRL International Grid Chase, an event encouraging hams to activate rare or remote Maidenhead grid squares all over the world.

Making the Plan

After looking for a grid to activate, I decided on an expedition to EN67 — a grid square just 6 hours from my home and almost entirely over water, except for the tip of the Keweenaw Peninsula in the Upper Peninsula, just outside of Copper Harbor, Michigan. Operation could take place atop Brockway Mountain, a pull-off loop at the high point of Brockway Mountain Drive that follows the backbone of the Keweenaw Peninsula. I pitched the idea to my friend and mentor, Troy Faulkner, KB9AZZ, who agreed to be a part of the adventure. Thus, the planning began.

From researching online, we discovered that the location and grid is occasionally activated by intrepid hams, such as a group led by Tim Rush, N8DUY, who activated EN67 in 2015 as K8N. We contacted Rush for advice, who informed us that we needed special permission and a signed agreement from the local township to stay overnight. He also said that we needed to plan for the possibility of high winds on the exposed ridge and rocky soil that wouldn't be conducive to staking ground rods or guy lines.

We obtained the necessary agreement and permits after picking our operating dates — the weekend after Labor Day 2018. To make this an official expedition, we acquired the special event call sign K8B for the activation and set up accounts for K8B on Logbook of The World and **QRZ.com**. To promote our activation, we contacted *QST* to get the event on the magazine's calendar and posted to two Facebook groups related to the ARRL Grid Chase.

Setting Up

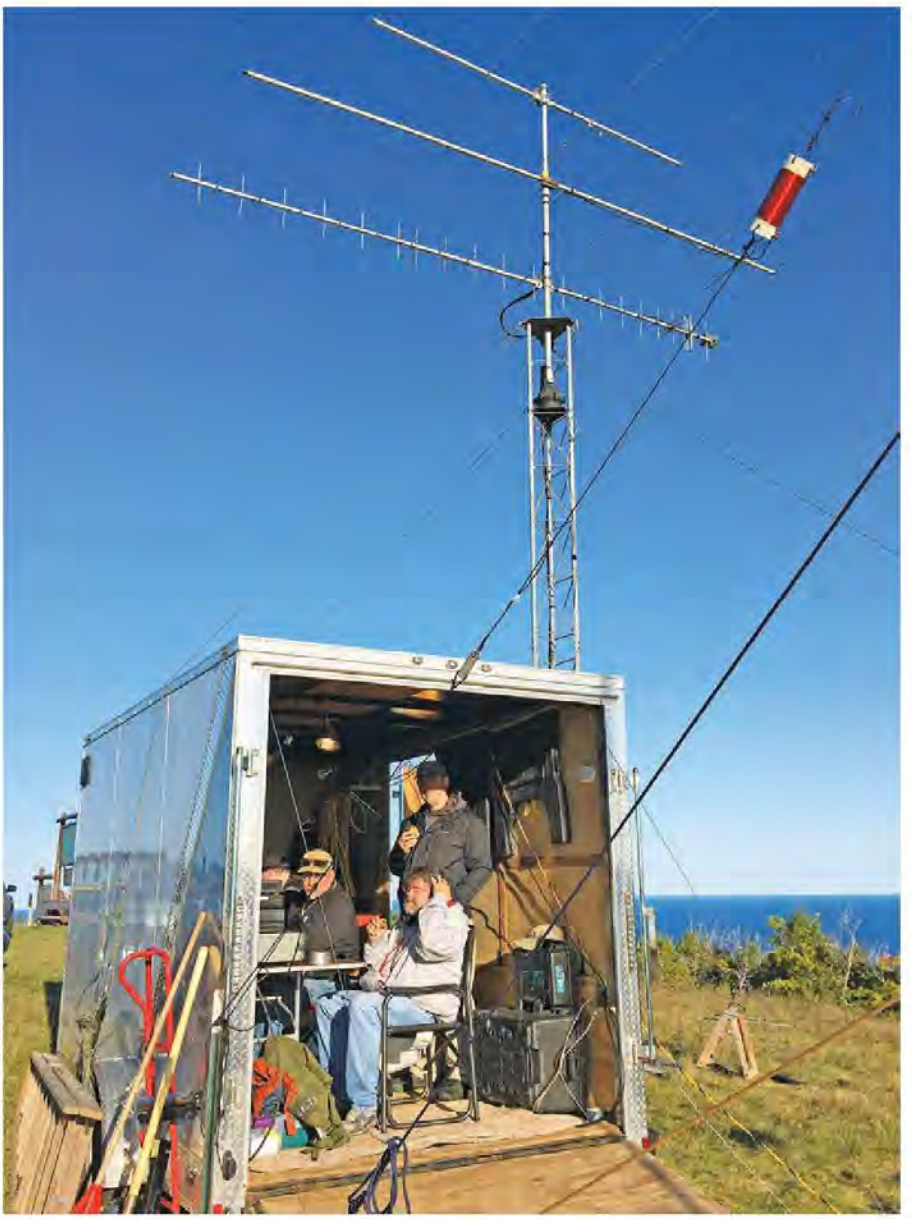
I'm a relatively new ham, but fortunately, Troy and the other operators have years of experience and piles of equipment to select from. The transceivers we decided to use were the Icom IC 7300, Kenwood TR-751A, Yaesu FT-857D, Yaesu VX-1R handheld, Yaesu FT-847, and Yaesu FT-625RD.

For antennas, we used an end-fed half-wave antenna supported on painter poles for 80 to 10 meters; a Hustler 5BTV for 80, 40, 20, 15, and 10 meters; a Collins Radio AS-2259/GR military antenna; a 35-foot guyed portable mast with a drive-on plate for inverted Vs and raising the ends of long wires; a homebrewed KGØZZ 40/80-meter inverted-V dipole; a four-element 6-meter beam; a 14-element 2-meter Hy-Gain/Telex 214B-S beam; a horizontally or vertically switchable polarized 70-centimeter beam, and a horizontal 80-meter delta loop thrown together for this activation. Along the way, we made a low-cost 35-foot mast and drive-on mast plate. We also had to factor in extra rope for guying options, extra stakes for shallow soil, and the grounding grid.

Troy served as our technical support in erecting antennas and grounding systems. He also invited other ham friends who could help activate the VHF and UHF bands. Matt Okeson-Harlow, NM9O, provided IT, network, and logging capabilities.

Table 1
K8B EN67 Grid Activation — QSO Counts

Band	CW	SSB/FM	FT8	Totals
70 centimeters		8		8
2 meters	10	13		23
6 meters		2	40	42
17 meters			8	8
20 meters	1		201	202
30 meters	3		19	22
40 meters	2	21	332	355
80 meters		8	18	26
Totals	**16**	**52**	**618**	**686**



The operating station for the VHF/UHF team. From left to right, Troy, KB9AZZ; Barry, K8SD, and Thomas, AC9BJ.

Contacts Near and Far

By 4 PM Friday, we had the primary antennas up and were operating. We tried several different modes and bands, but a lot of our contacts were on FT8, as band conditions were not favorable. Days were beautiful and sunny with light winds (as we were warned), but it was nothing our setup couldn't handle.

I converted my 2004 Honda Odyssey van into a mobile operating station for the trip. With the antennas, generators, and fuel deployed outside the van, I had room to sleep alongside my clothes, food, and water supply. The other operators worked out of a trailer converted into an operating station and slept in their vehicles or headed back into town for the night. Despite band conditions, we had a lot of fun.

Visitors stopped by throughout the weekend and the sign we were required to post, per our agreement with the town, was useful in explaining our activity. Occasionally, a ham stopped by with a mobile 2-meter rig, Troy would use a handheld transceiver to make a contact, and we'd add them to the log.

We made 686 contacts (see Table 1) and, by the Wednesday after the event weekend, we were already receiving QSL cards in the mail. For a relatively new ham, this portable operation made for a more manageable and exciting "DXpedition" experience. By all measures, my team and I deemed it a success.

Photos by the author.

As a teen, Dan Brandner, N9DJB, was interested in everything science related, including electricity, magnetism, and electronics, and he followed that passion into obtaining a degree in chemistry and computer science. In August 2017, he passed both his Technician and General licensing tests in one day.

In January 2018, he retired from his career at Land O'Lakes, Inc., and was able to focus more on ham radio activities, particularly building and fabricating. He built the 35-foot mobile mast used in the 2018 ARRL Grid Chase, as well as the "Coil-Loaded 40/80 Meter Inverted V Dipole Antenna" project from Zed Zed's Workbench, which was used with that mast.

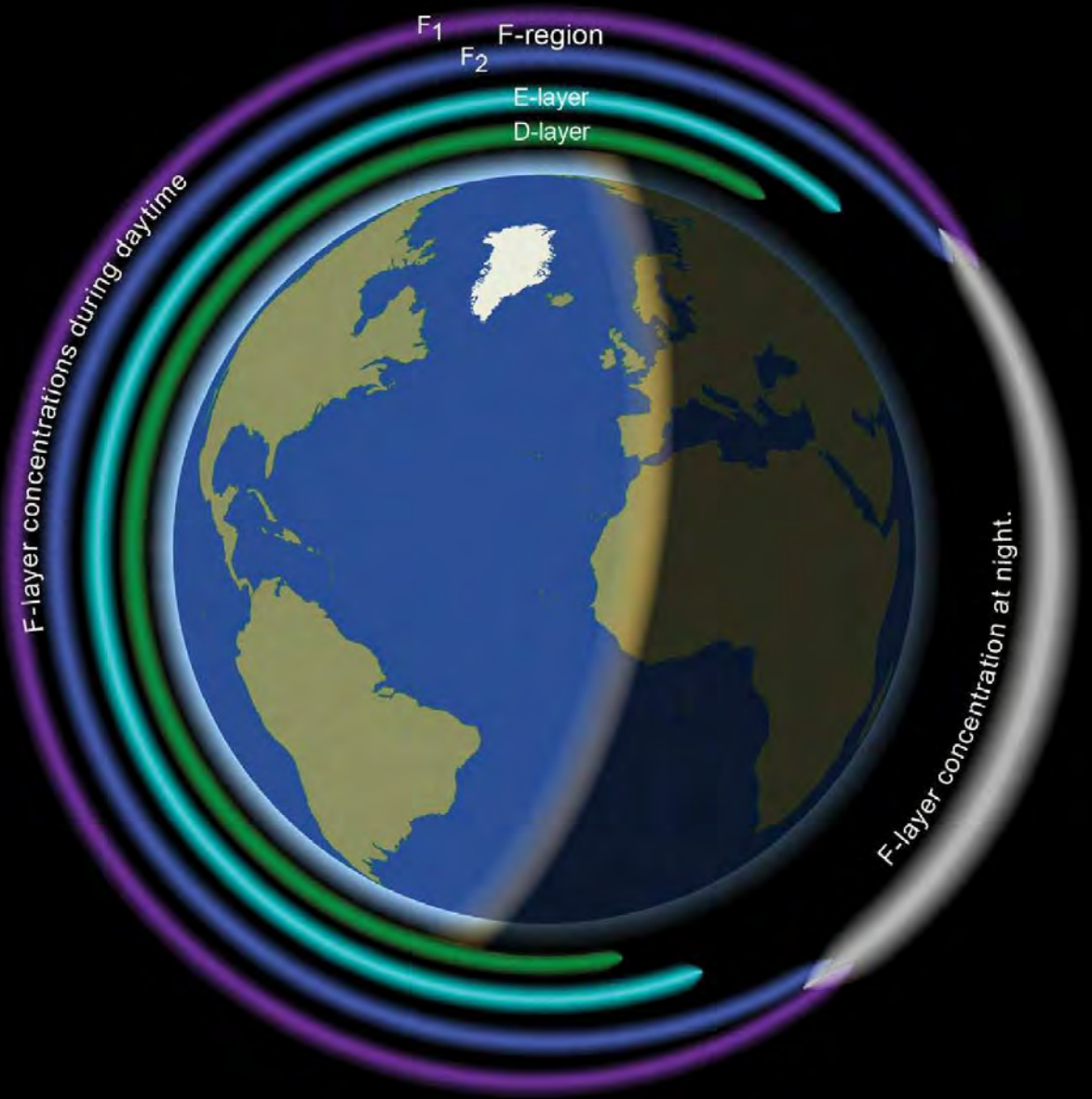
For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Dan Brandner's, N9DJB, operating position in his van.

Erection of the 35-foot mast with drive-on plate and multiple guy ropes. On the side of the van is the banner created per the sign posting agreement, declaring the team's amateur radio activation of EN67 and the hours of operation.

How the Ionosphere Was Confirmed

A timeline of the tools and methods used to confirm the existence and height of the ionosphere.



Robert H. Welsh, N3RW

From the beginning of the 20th century to the 1930s, physics experienced a revolution with a new understanding of quantum mechanics. Long-wave radio broadcasting grew, with new scientific studies following. Further investigation of the effects of high-energy, subatomic particle collisions with high-voltage pulse generators led to the development of new wavelength theories, such as the Austin-Cohen equation, which states that, as wavelength decreases, radio waves travel over longer distances. Given this hypothesis, the shorter wavelengths were considered useless for long-distance radio communications, and were relegated to radio amateurs, who found great success transmitting reliably over long distances.

Understanding the evolution of the methods used to study ionospheric conditions can determine success for DX chasing and shortwave listening today.

December 1901

Guglielmo Marconi received a transatlantic radio signal from Cornwall, England, to Newfoundland, Canada. From this trial, the concept of radio waves traveling over long distances was introduced.

1902

Arthur Edwin Kennelly of the US and Oliver Heaviside of England hypothesized the existence of a conducting layer in the upper reaches of Earth's atmosphere.

1909 – 1917

A.H. Taylor, a physicist and professor at the University of North Dakota, experimented with radio waves and investigated the relation between weather and received signal strength.

1912

A federal law was enacted to restrict amateurs to frequencies above 1,500 kHz — a government policy that greatly extended shortwave experimentation.

1912 – 1914

Dr. Lee de Forest and Dr. Leonard F. Miller at the Federal Telegraph Company made the first crude measurements of the Kennelly-Heaviside layer height using a spark transmitter that delivered 1,200 kW to an antenna at currents approaching 750 A. The wavelength of the transmitter was 3,260 meters (a frequency of 92 kHz). De Forest called this "apparent selective absorption" and hypothesized that the main wave was returned by a reflecting layer whose heights were 17, 27, and 37 miles above Earth. Pierce calculated the reflecting layer's height to be 192 miles.

1918 – 1923

William F.G. Swann studied the conductivity of the upper atmosphere at the University of Minnesota. Swann suggested an experiment to measure the distance of the conducting layer by measuring the time taken by wireless waves to reach that layer and return. Unfortunately, Swann's experimental procedure failed as the receiver was not fully blanked during the transmitted pulse.

1924

Albert Hoyt Taylor and his colleagues at NRL, in cooperation with John L. Reinartz, 1XAM/1QP, of the ARRL, and other radio amateurs discovered *skip distances* in which high-frequency radio waves could be transmitted to a distant receiver, while being imperceptible at many points in between.

Gregory Breit, a mathematical physicist in the Department of Terrestrial Magnetism (DTM) at the Carnegie Institution of Washington, and Merle Tuve, a PhD candidate at Johns Hopkins, investigated the conducting layer, attempting an experiment using a parabolic reflector and transmitted in the 90 MHz range to measure the height of the reflecting layer. The reflector was never built, which is fortunate in retrospect, because a 90 MHz signal would not be reflected back by the ionosphere, except under sporadic-E layer reflections. Further attempts were at much lower frequencies owing to Breit's cooperative efforts from stations in New Jersey and Massachusetts.

The best results were received from the NRL transmitter, which was one of the earliest crystal-controlled transmitters in use. Breit and Tuve used the new technique of oscillograph recording to analyze the received pulses.

The E-layer is the lower part of the ionized layer at an altitude of between 56 kilometers to 104 kilometers (35 miles to 65 miles) above the Earth's surface. The upper layer — divided into two layers (F1 and F2) — exists almost all the time, whereas the E-layer comes and goes depending on solar activity.

July 28, 1925

Breit and Tuve received the first conclusive results of ionospheric reflection at a frequency of 4.2 MHz from a 10 kW transmitter sending 200-microsecond pulses. Their results showed that the height of the reflecting layer varied from day to night. Their calculations indicated that the height ranged from 55 miles during the day, but it rose to 130 miles at night. They were not yet aware that the layers varied as a result

of solar ultraviolet and X-ray emissions, which did not excite the atmosphere when the sun was not visible. Today, users of the HF spectrum recognize that there are several layers at different heights: D at about 30 miles, E at about 60 miles, and F_1 and F_2 at heights around 180 miles.

To measure the ionosphere's height, Breit and Tuve followed the following procedure:

1) Use directional loop antennas for receiving.

2) Record the received pulses from both the sky-wave signal and ground-wave signal.

3) Apply the time difference between the sky-wave signal and the ground-wave signal.

4) From the difference, use their derived equation to measure the layer height.

5) Use a derivation of the Pythagorean theorem to compare the time for the sky wave and the ground wave to reach the receiver. From the difference in the two arrival times, Breit and Tuve calculated the height of the reflecting layer to be about 80 miles.

1945 – 1990

During the Cold War, high-frequency radio systems were still in wide use by many military organizations around the world. Using oblique sounders to provide the conditions of the ionosphere, the US could monitor radio transmissions between foreign government and military systems that were refracted from the ionosphere. One such system operated at 28 MHz, prompting the use of sporadic E-layer refraction for interception of foreign signals of interest.

The specified purpose for the oblique sounder was to receive, record, and display the echoes of the transmitted pulse. The reflected signals were used to determine sporadic-E conditions, magnetic field-aligned inequalities, disturbances in the F-region, and possible tilt of the ionosphere. Software was written to analyze the data collected by the sounder. Operational results of this system currently fall under high levels of security classification.

Current Day

Today, the most common system used is the ionosonde, a vertical incidence pulsed radar operating at a frequency range of about 1 MHz to 40 MHz. The measurement is based on the equation: $h = 0.5 \times c \times t$; where c = the speed of light, t = is the travel time of the pulse, and h is the layer height (or virtual height).

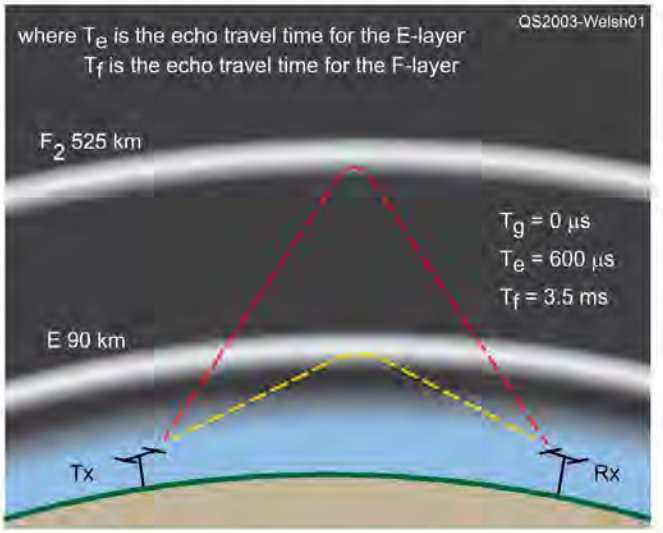


Figure 1 — A low-power ionosonde simultaneously measures seven observable parameters of reflected signals received from the ionosphere to estimate the height of the ionosphere. Here, T_e is the echo travel time for the E-layer, and T_f is the echo travel time for the F-layer.

Among other ongoing research to study the ionosphere, the University of Massachusetts Lowell Center for Atmospheric Research has developed a low-power (300 W) ionosonde (Digisonde™) which has the capability of portable operation with simultaneous measurement (see Figure 1) of seven observable parameters of reflected signals received from the ionosphere: frequency, range or height, amplitude, phase, Doppler shift and spread, angle of arrival, and wave polarization.

Impact

Commercial, military, and amateur users of the HF, VHF, and UHF regions of the electromagnetic spectrum owe much to past and present experimenters. They provide the communications community with an understanding of how signals propagate around our planet. As users of the electromagnetic spectrum, we rely on this information to better communicate by radio.

Robert H. Welsh, N3RW, is an Assistant Professor of Physics and Astronomy at Bucks County Community College in Newtown, Pennsylvania, where he is a faculty sponsor of club station KB3YRR. Robert also occasionally performs microwave radio galactic studies at the National Radio Astronomy Observatory in Green Bank, West Virginia. He was part of the Microwave Galactic Plane Survey using a dual-frequency radio telescope operating at 9.7 GHz and 14.3 GHz. Robert is an active chaser for DX entities and Islands on the Air.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

ARRL

Eclectic Tech

A New Technical Podcast for Amateur Radio!

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Starting February 13, you'll have a new podcast for your listening pleasure. Hosted by Steve Ford, WB8IMY, ARRL's *Eclectic Tech* will treat you to a broad discussion of science and technology as it applies to amateur radio, including new technology that may impact the future of amateur radio — for better or worse.

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STITCHER

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The Saga of Clipperton Island

This DX entity (FO/C) frequently ranks high on Club Log's Most-Wanted List, but the island is also infamous for its long, turbulent history.

The masked boobies are very common on Clipperton Island. [Robert Schmieder, KK6EK, Cordell Expeditions, photo]

Allison McLellan

Those who have journeyed 700 miles southwest of Acapulco, Mexico, to Clipperton Island include pirates, castaways, military personnel, scientists, and amateur radio operators. As a DX entity, Clipperton (FO/C) currently ranks number 45 worldwide on Club Log's Most-Wanted List, and number 35 in Europe. The island tends to stay relatively high in DX ranking, in part due to its remote and inhospitable shores.

Far From Paradise

The 2.3-square-mile atoll of Clipperton is a flat ring of land surrounding a lagoon, with its most distinguishing feature being Clipperton Rock — the 70-foot-tall remains of the volcano that formed the island in its isolated area of the Pacific. The rough reefs surrounding its coast create a tumultuous surf, but those who end up in an overturned boat have more to worry about than sharp coral. Clipperton is known for an abundant shark population, with frequent sightings of moray eels.

After making it to shore, there is the environment to contend with. Scarce vegetation lends little shade due to the large crab population depleting greenery. The island is also known for its many seabirds and subsequent abundance of guano — bird waste that is high in phosphate, making it a valuable resource as fertilizer. At one point, the Mexican government brought wild pigs to the island that ate the bird eggs and crabs, allowing some vegetation growth. However, the animals were also said to "drive men into the surf" with their tusks, and eventually, the pigs were killed off to preserve the natural habitat.[1]

Despite short periods of human occupation, the area is considered to be among the least disturbed ecosystems in the Pacific.[2] In recent years, National Geographic research teams conducted dives and land surveys at Clipperton and concluded, "The beautiful nearshore reefs — measured in species per area — held the highest number of endemic species anywhere in the world."[3]

An Island in Demand

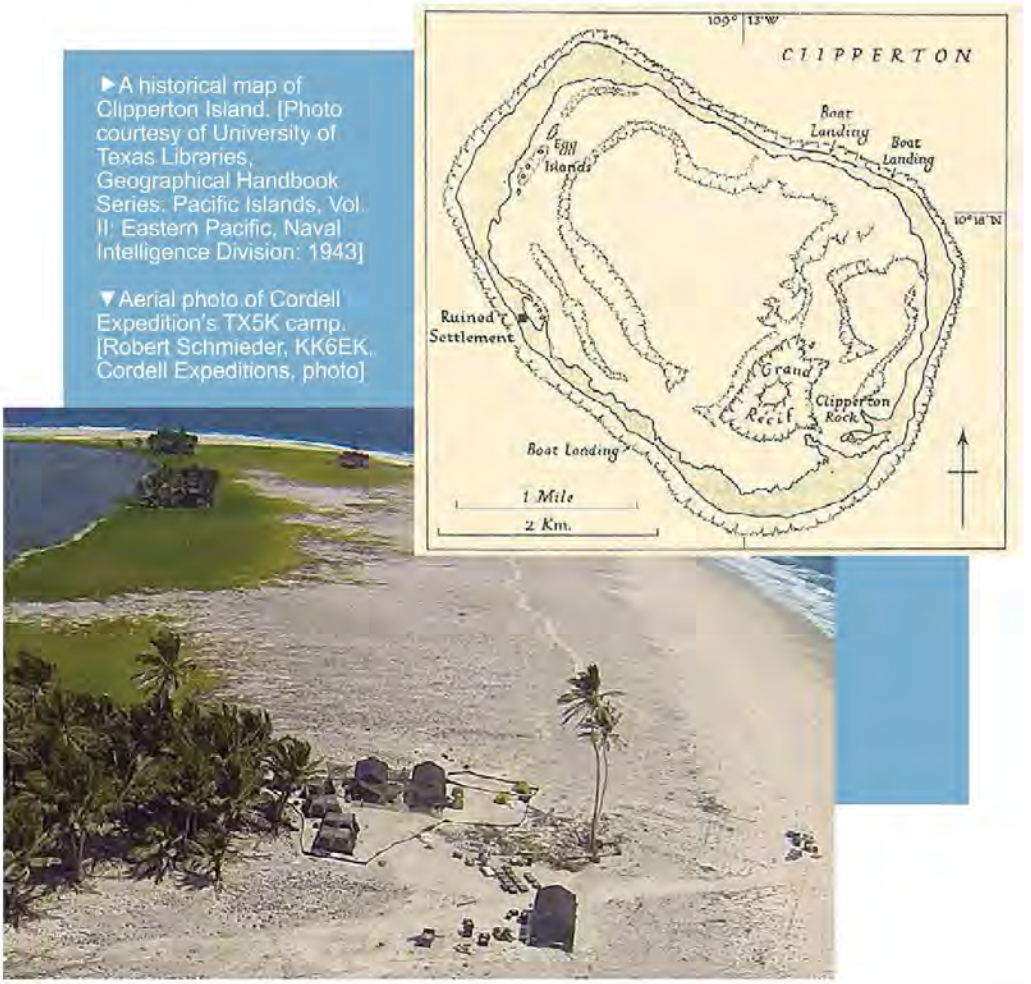
Before it became a destination for rare Amateur Radio contacts, Clipperton Island was at the center of an ownership dispute between France, Spain, Mexico, and the United States. The island was discovered by Ferdinand Magellan in 1521, and later named after the English pirate John Clipperton. According to legend, Clipperton left treasure hidden on the small island.

In 1858, France wanted to claim the land, but its boats could not make it to shore. The crew settled for circling the island in their ship while reading a proclamation of ownership and left it at that. However, in 1892, the US annexed Clipperton under the Guano Islands Act of 1856, which declared "any guano islands unclaimed or unoccupied by others could be claimed and mined, and the guano delivered to the United States at a low price for the benefit of its citizens."[4] But the expenditure did not prove to be very lucrative, especially with the expense of shipping supplies to mining crews on the island.

With Clipperton's proximity, it was Mexico's turn to stake claim on the island, and it did not take much to do so. A group of Mexicans sailed over and distracted the miners long enough to replace the American flag atop a 40-foot-pole with a Mexican one. As the island was becoming more trouble than it was worth, the US conceded.

Thus, the dispute continued between Mexico and France, and Mexico sent a 13-man army to protect its claim. Soldiers' servants and wives accompanied them and bore children, eventually growing to a population of 26. However, as the Mexican government was forced to divert resources to its rising revolution, attention on the settlement dwindled until suddenly, supply ships stopped coming. Left isolated on Clipperton's unforgiving soil with only birds, eggs, and fish to eat, many developed scurvy and succumbed to illness — especially the men. With one boat too low on fuel to reach land and the five remaining men too weakened to sufficiently row, escape options were limited. Nevertheless, in an effort to reach a ship believed to be seen on the horizon, the men took the canoe to sea, but capsized and drowned. Not long afterward, a hurricane tore through the settlement.

Emerging among the wreckage, the Clipperton lighthouse keeper — the only remaining man on the island who had since stayed isolated in his lighthouse quarters — declared himself king. He took control of the weapons and abused the women into servitude for nearly 2 years. Finally, in July 1917, two of the women were able to overpower and kill the lighthouse keeper, ending his reign of terror. The three women and eight children were soon rescued by the American USS *Yorktown*, which was in the area patrolling for German U-boats.



▶A historical map of Clipperton Island. [Photo courtesy of University of Texas Libraries, Geographical Handbook Series: Pacific Islands, Vol. II: Eastern Pacific, Naval Intelligence Division: 1943]

▼Aerial photo of Cordell Expedition's TX5K camp. [Robert Schmieder, KK6EK, Cordell Expeditions, photo]

Following the island's desertion, France approached the Vatican to settle the ownership dispute with Mexico, and the decision was turned over to King Victor Emmanuel III of Italy. A 1936 decree established Clipperton under the Government of the French Establishments of Oceania.[5]

Afterwards, the French briefly used the island for a military outpost, leaving after 7 years. Throughout World War II, the US Navy occupied the island under secretive operation. In 1998, NASA constructed an expensive tracking facility there, but it, too, was abandoned only months later. Since then, the island has remained virtually uninhabited — save for the occasional DXpedition.

The Cordell Expedition's Clipperton DXpedition team and their banners. [Robert Schmieder, KK6EK, Cordell Expeditions, photo]

Amateur Radio on Clipperton

According to the German DX Foundation (**www.gdxf.de/megadxpeditions**), there have been five "mega" DXpeditions to the entity. In 1985, FO0XX achieved 30,958 contacts; in 1992, FO0CI reached 46,044; FO0AAA hit 75,107 in 2000; TX5C obtained 71,798 in 2008, and the large TX5K team got a whopping 113,603 in 2013. But given the very nature of Clipperton, these DXpeditions could not be without obstacles.

Robert Denniston, W0NWX, was the first to lead a crew as FO8AJ in 1954, an endeavor plagued by what he called "a permanent state of bad luck" in the July 1954 issue of *QST*. Following a struggle to find suitable transportation, the crew's sextant broke on their second night at sea, leaving them unable to navigate. After a week, they were forced to return to the mainland, seasick and disheartened.

When FO8AJ finally coordinated a new ride to Clipperton, the journey was filled with more issues, including oil and water leaks, torn sails, and a dead battery in the ship's system. They gained sight of the elusive island by nightfall of the sixth day, but it was too dark to land. By daybreak, they had been pushed off course by wind, and the boat engines quit just in time for an approaching storm. The overcast sky made it impossible to navigate for days, until the rain cleared on the one day of the year when the sun is directly overhead, making navigational readings unreliable.

The next day, the team finally obtained a location measurement and made it to Clipperton. Despite a damaged generator causing noise in the receiver, contacts were successful, particularly on 20-meter CW. The hams remained on the air until the last possible moment, when the Mexican Navy ordered their departure, garnering a total of 1,108 contacts over 18 hours of operation.

The DXpeditions following Denniston's pilgrimage did not get much easier. The 1985 FO0XX team was forced to circle the island for 4 days in a tropical storm before they could battle ashore. Their first 2 days were full of storms that ravaged their camp, and during fierce operation pileups, they found the island's crabs, birds, and roaches were not particularly afraid of people. It wasn't all a struggle; on the third day, a helicopter pilot working with a tuna fishing company came across the operators and gave them their only 2-meter contact with his chopper's Kenwood radio. Then he flew the team to the fishing ship for a guided tour, where they were refreshed with cold drinks, fresh food, and brandy.

The 2000 FO0AAA DXpedition fared better with an experienced ship crew that frequented Clipperton Island for fishing trips. However, the team was greeted with an hour of intense rain and wind as soon as they got to shore. The exhausted men settled into bed for what FO0AAA team member Michael Goode, N9NS, called, "Without reservation, [the] worst night in my life," with a carpet of crabs scuttling below his cot.[6] But the team enjoyed exploring the location and its ruins from the abandoned military operations and settlements. As they packed up their gear, Goode said the team was both happy and sad to go home.

With such a hostile environment, it's a wonder Clipperton is ever selected as a DXpedition destination. Dr. Robert Schmieder, KK6EK, of Cordell Expeditions, helped organize the 2013 TX5K DXpedition, which brought a five-person team of scientists to monitor the island environment in addition to operation. This research component was essential in funding the trip, and the group was able to collect samples to identify a new microscopic animal on the island.

"Clipperton is an astonishing physical object — in the remote ocean, here is a ring of sand, 7 miles around, populated by various flora, fauna, and ruins of previous occupations," Schmieder said. "It's a romantic place, tied to pirates and a continuing series of scientific projects. And it's a visually spectacular atoll."

Regardless of destination, any DXpedition can be a harrowing process, from planning logistics to operating for hours on end. For radio amateurs, it's all worth it to make thousands of contacts from a new location and bond with fellow hams. Clipperton Island has remained stubbornly untamed for hundreds of years, but if a ham is brave enough to test its waters, the adventure may at least be worth the story.

Notes

[1]R. Denniston, W0NWX, "DXpedition to Clipperton," *QST*, July 1954, pp. 10 – 15.
[2]M. Jenkins, C. Sheppard, and S. Wells, *Coral Reefs of the World*, Volume 3: Central and Western Pacific (Nairobi, Kenya: UNEP; Gland, Switzerland: IUCN, 1988).
[3]P. Rose, "Why Clipperton Island is a 'Beautiful, Powerful Surprise!'" National Geographic Society Newsroom, Mar. 24, 2016, **https://blog.nationalgeographic.org/2016/03/24/why-clipperton-island-is-a-beautiful-powerful-surprise/**.
[4]"The Guano Islands Act of 1856," National Museum of American History — Behring Center, **https://americanhistory.si.edu/norie-atlas/guano-islands-act**.
[5]J. Pike, "Clipperton/Ile de la Passion — History," July 24, 2017, **https://www.globalsecurity.org/military/world/oceania/cp-history.htm**.
[6]M. Goode, N9NS, "Clipperton 2000," *QST*, Feb. 2001, pp. 54 – 58.

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For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

Nominations Now Being Accepted for 2020 McGan Silver Antenna Award for Excellence in Public Relations

This annual award honors successful volunteer efforts to keep amateur radio in the news.

ARRL Public Information Officers (PIOs) and other volunteers work hard every day to create a better understanding by the public of all that amateur radio has to offer. They publicize special events, write press releases, and give interviews on radio, television, or in newspapers to highlight the value and service that amateur radio provides. Their efforts benefit us all.

The award is named for the late journalist Philip J. McGan, WA2MBQ, who served as the first chairman of ARRL's Public Relations Committee.

As a way of recognizing these efforts, the ARRL Public Relations Committee solicits nominations for the Philip J. McGan Memorial Silver Antenna Award, which is presented annually to an amateur radio operator who has demonstrated success in his or her public relations efforts on behalf of amateur radio and who best exemplifies the volunteer spirit of Philip McGan.

McGan, WA2MBQ (SK), a journalist himself, was the first chairman of the ARRL's Public Relations Committee, which helped reinvigorate ARRL's commitment to public relations. To honor McGan, members of the New Hampshire Amateur Radio Association joined with the ARRL Board of Directors to establish an award that would pay lasting tribute to the important contributions he made on behalf of amateur radio.

Public relations activities for which the McGan Award is presented include efforts specifically directed at bringing amateur radio to the media's and public's attention in a positive light. This may include traditional methods, like sending out news releases or arranging interviews, or less-traditional methods, such as hosting a radio show or being an active public speaker.

The ARRL Board of Directors will choose the award winner at its July 2020 meeting, based on recommendations from the ARRL Public Relations Committee, which reviews the nominations and accompanying submitted material.

Recent winners of the award include:

- John Wells, W4CMH (2019)
- E. Gordon Mooneyhan, W4EGM (2018)
- Dennis Moriarty, K8AGB (2017)
- Tom "Tex" Ritter, WY7KY (2016)
- Randy Thompson, K5ZD (2015)

The award is given only to an individual (not a group), who must be a full ARRL member in good standing at the time of nomination. The nominee must not be compensated for any public relations work involving amateur radio (including payment for articles), and may not be a current ARRL officer, director, vice director, paid staff member, or a member of the ARRL Public Relations Committee.

The nominee's efforts must fit the definition of public relations, which is fundamentally about getting a message out to people, as opposed to public service, which is about providing service to the community. The McGan Award is for promotion of amateur radio to the non-amateur radio community; it is not awarded for work done within a club or organization that primarily benefits the amateur radio community.

Nominations must be received at ARRL Headquarters in Newington, Connecticut by the **close of business on Friday, May 15, 2020**. Nominations must be on an official entry form, which can be found and downloaded in PDF format from **www.arrl.org/phil-mcgan-award**. Anyone may make a nomination.

Rick Lindquist, WW1ME, ww1me@arrl.org

Happenings

Volunteer Monitor Program Coordinator Looks Forward to a Positive 2020

In a message to ARRL leadership and members of the new ARRL Volunteer Monitor (VM) program, its coordinator, Riley Hollingsworth, K4ZDH, expressed gratitude to all involved for their contributions to getting the program off to a solid start in January.

"It will be a good year," Hollingsworth said. "We will have fun, you will enjoy it more than you probably think, and thanks to the talent and generosity of one of our VMs, a computer program will make your reporting much easier (there will be no need for bimonthly reports!)," he wrote. "This is our opportunity to help amateur radio last another hundred years and to pay forward this wonderful avocation that joyfully occupies our lives. This could be our legacy if we do it with all the energy and devotion that characterized the Official Observer (OO) program for decades."

Hollingsworth said the success of the OO program convinced the FCC to trust ARRL with the responsibilities now being taken up by the Volunteer Monitor program. "Those of you who are former OOs have an extra reason to be proud, and amateur radio is grateful to you more than you will ever know," Hollingsworth concluded. "Thank you. It will be a privilege to work with you this new year."

Approved by the ARRL Board of Directors in 2018, the Volunteer Monitor program supplants the venerable OO program. The VM program represents a formal agreement between the FCC and ARRL in which volunteers trained and vetted by ARRL will monitor the airwaves and collect evidence that can be used to correct misconduct. The program will also recognize exemplary on-air operation. ARRL will refer cases of alleged flagrant violations to the FCC.

The FCC proposed the new program in the wake of several FCC regional office closures and a reduction in field staff. It will give enforcement priority to cases developed by the Volunteer Monitor program without ARRL's having to refer cases through the FCC online complaint process.

ARRL *On the Air* Podcast Premieres

ARRL's new *On the Air* podcast for those just getting started on their amateur radio journey debuted in mid-January, with a new episode posted each month. The podcast is a companion to the new bimonthly *On the Air* magazine. *On the Air* magazine's Editorial Director Becky Schoenfeld, W1BXY, is hosting the new podcast. Both the podcast and the magazine are aimed at offering new and beginner-to-intermediate-level radio amateurs a fresh approach to exploring radio communication.

Listeners can find the podcast at Blubrry, Apple iTunes (or by using your iPhone or iPad podcast app — search for "*On the Air*"), and Stitcher (or through the free Stitcher app for iOS, Kindle, or Android devices). Episodes will be archived on the ARRL website.

Each episode will take a deeper dive into the articles and issues raised in the magazine, including advice and insight on topics covering the range of amateur radio interests and activities: radio technology, operating, equipment, project building, and emergency communication.

A new Facebook page (**www.facebook.com/ARRLOTA**) will supplement the *On the Air* podcast.

ARISS Next-Generation Radio System Ready for Launch to Space Station

Amateur Radio on the International Space Station (ARISS) reports that its first Interoperable Radio System (IORS) flight unit — serial number 1001 — has been delivered to NASA's Johnson Space Center for launch in early March. The IORS represents the first major upgrade in ARISS equipment on the International Space Station since amateur radio gained a permanent presence onboard the ISS in 2000. Last December, ARISS received approval from NASA Safety to launch the IORS on SpaceX CRS-20 and stow the radio system on the ISS for future installation.

"The IORS is a foundational element of the ARISS next-generation radio system and is an incredible engineering achievement by the ARISS hardware team," ARISS International President Frank Bauer, KA3HDO, said. "This first element delivery will support easier radio mode transitions and enable new, exciting capabilities for hams, students, and the general public."

The new system includes a higher-power radio, an enhanced voice repeater, and updated digital packet radio (APRS) and slow-scan television (SSTV) capabilities for both the US and Russian space station segments. The IORS consists of a custom-modified JVC Kenwood TM-D710GA transceiver, an AMSAT-developed multi-voltage power supply, and interconnecting cables.

The IORS, set to launch in March, will be installed in the ISS *Columbus* module; a second flight unit is expected to be launched later this year for installation in the Russian *Service Module*. The ARISS hardware team will assemble four flight units — and 10 IORS units in all — to support onboard flight operations, training, operations planning, and hardware testing.

"Future upgrades and enhancements to the next-generation system are in various stages of design and development," Bauer said. "These include a repaired Ham Video system — currently planned for launch in mid-to-late 2020 — L-band (uplink) repeater, ground command operations capability, LimeSDR signal reception, a microwave 'Ham Communicator,' and Lunar Gateway prototype experiment."

Bauer said a lot of "heavy lifting" remains to prepare the IORS for operation on the space station. "ARISS has 92 engineering requirements and our operations Phase III safety review to complete," he explained. "The space agencies take a position of 'trust, but verify.' Thus, these engineering and safety 'verifications' all need to be closed out before the IORS can be unstowed and turned on."

Bauer reminded that ARISS is almost entirely run by volunteers and encouraged donations for next-generation hardware developments, operations, education, and administrative functions. Donations can be made at **www.ariss.org/donate.html**.

Radio Amateurs of Canada Announces a New Section

The number of Sections needed for a clean sweep in the ARRL November Sweepstakes (SS) will rise to 84 in 2020, with the addition of a new Prince Edward Island (PE) Section. Radio Amateurs of Canada (RAC) has announced that the new Section will become effective April 1. Prince Edward Island has been in the Maritimes (MAR) Section.

RAC said its Prince Edward Island members have been working for some time to create a separate Section for RAC ARES activities there. The provinces of Nova Scotia and New Brunswick will remain in the Maritimes Section.

In addition to Field Day and Sweepstakes, the new Section in Canada will affect the ARRL 160-Meter Contest but *not* the ARRL 10-Meter Contest, which uses individual states/provinces for US and Canadian multipliers. The change will mean that logging software developers will have to update their software to include the PE Section as a valid exchange element for any affected operating events.

RAC also announced that, effective April 1, radio amateurs in the City of Hamilton and in the Regional Municipality of Niagara will shift to the Greater Toronto Area (GTA) Section from the Ontario South (ONS) Section.

China Telecoms Regulator Proposing to Delete Some Current Amateur Allocations

China's telecommunications regulator has proposed amending the *Measures for the Administration of Amateur Radio Stations*, and some amateur bands are in danger of being eliminated. The proposal would prohibit amateur operation on the 2200-meter band as well as on 146 – 148 MHz, 1260 – 1300 MHz, 3400 – 3500 MHz, 5650 – 5725 MHz, and all bands above 10 GHz.

Radio communications engineer and Chinese Amateur Satellite Group (CAMSAT) CEO Alan Kung, BA1DU, told ARRL that government efforts to eliminate some amateur bands are nothing new, but proposals that have been aired for a while now are on the regulatory agency's schedule. Kung said he does not anticipate that all of the bands proposed will be taken away, but he conceded that the climate will "undoubtedly" become increasingly dangerous for China's amateur radio community.

"The attempt to crowd out the amateur radio bands has a long history throughout the world," he said, "but it may never have become so urgent for the amateur radio community as it is today. We all understand that radio spectrum resources have become a bottleneck for further development." He said today's radio communication industry "is working hard to share spectrum resources."

New Section Manager Taking Over in North Carolina

Marvin Hoffman, WA4NC, takes the reins of the North Carolina ARRL Field Organization on April 1. Hoffman, of Boone, was the sole nominee to succeed incumbent Section Manager Karl Bowman, W4CHX, who decided not to run for a new term after serving since 2014. Because no challengers came forward by the nomination deadline, no contested SM elections took place during the winter election cycle.

These incumbent Section Managers begin new terms on April 1: John Fritze, K2QY, Eastern New York; George Miller, W3GWM, Eastern Pennsylvania; John Mark Robertson, K5JMR, Louisiana; Joe Speroni, AHØA, Pacific; Dave Kaltenborn, N8KBC, San Diego; Chris Stallkamp, KIØD, South Dakota, and Joe Palsa, K3WRY, Virginia.

Elsewhere, John Litz, NZ6Q, was appointed in January as ARRL San Joaquin Valley Section Manager, succeeding Dan Pruitt, AE6SX, who passed away on December 27. He had served as SJV SM since 2009. Litz will complete the remaining term of office that runs through June 30, 2021. From Stockton, California, Litz was first licensed in 1974 and is an ARRL Life Member. He had been serving as an Assistant Section Manager in San Joaquin Valley.

Nominations Solicited for Six ARRL Awards

ARRL is inviting nominations for awards that recognize educational and technological pursuits in amateur radio. Nominations are also open for ARRL's premier award to honor a young licensee.

The Hiram Percy Maxim Award recognizes a radio amateur and ARRL member younger than age 21, whose accomplishments and contributions are of the most exemplary nature within the framework of amateur radio activities. Nominations for this award are made through ARRL Section Managers, who will forward nominations to ARRL Headquarters. The deadline is March 31, 2020.

The ARRL Herb S. Brier Instructor of the Year Award honors an ARRL volunteer amateur radio instructor or ARRL professional classroom teacher who uses creative instructional approaches and reflects the highest values of the amateur radio community. The award highlights quality of and commitment to licensing instruction. Nominations are due by March 16, 2020.

The ARRL Microwave Development Award pays tribute to a radio amateur or group of radio amateurs who contribute to the development of the amateur radio microwave bands. The nomination deadline is March 31, 2020.

The ARRL Technical Service Award recognizes an individual radio amateur or group of radio amateurs who provide amateur radio technical assistance or training. The nomination deadline is March 31, 2020.

The ARRL Technical Innovation Award is conferred on an individual radio amateur or group of radio amateurs who develop and apply new technical ideas or techniques in amateur radio. The nomination deadline is March 31, 2020.

The Knight Distinguished Service Award recognizes exceptional contributions by a Section Manager to the health and vitality of ARRL. The nomination deadline is April 30, 2020.

The ARRL Board of Directors selects award recipients, and winners are typically announced following the Board's July meeting. For more information about these awards, visit **www.arrl.org/arrl-award-nominations**, or contact Steve Ewald, WV1X, at **wv1x@arrl.org** or 860-594-0265.

In Brief...

- **The Boy Scouts say JOTA station participation was up in 2019.** Although overall Jamboree On the Air (JOTA) 2019 participation was down slightly from 2018, "our calculations show that each station averaged an additional 13 people in attendance over 2019," the Scouts said. "This shows an aggregate increase of 24% attendance per station, even with our reported stations being down from 266 in 2018 to 201 in 2019." The Scouts reported that 13,783 individuals took part in JOTA 2019, down from 14,708 in 2018.

- **Stephen Veader, N4DXS, of Dale City, Virginia, a major behind-the-scenes player in the effort that led to creation of amateur radio's 60-meter band in the US, passed away on November 5.** An ARRL Life Member, he was 67. As a spectrum manager for the National Telecommunications and Information Administration (NTIA), Veader was deeply involved on the behalf of NTIA in the effort to secure a new amateur band at 5 MHz. According to Ross Merlin, WA2WDT, when it became clear that a proposal for a 15 kHz band would not be approved, Veader was instrumental in fashioning the compromise that led to the authorization of the five discrete secondary channels radio amateurs have today, and other countries copied that template for their 5 MHz amateur allocations. Today, these spot frequencies serve as "interoperability channels" for federal and amateur stations to share in emergencies and exercises. — *Thanks to Ross Merlin, WA2WDT*

- **CAMSAT's CAS-6 activation for amateur use has been delayed.** Some problems with the precise attitude determination of CAS-6 were reported to be delaying antenna deployment. The satellite was to have been put into service within 3 days of launch. Work to resolve the issue was to be completed sometime in late February or early March. The satellite's 145.910 MHz CW beacon has been turned on, although the antenna had not yet been deployed. — *Thanks to Alan Kung, BA1DU*

- **The lead developer of the bar code system that became the now-ubiquitous Universal Product Code (UPC), George Laurer, K4HZE, of Wendell, North Carolina, passed away on December 5.** He was 94. While an electrical engineer with IBM in North Carolina's Research Triangle Park in the early 1970s, Laurer led the effort to develop the bar code system. The UPC, composed of 30 unique black bars and a 12-digit number, allows retailers to identify products and prices as they are scanned. It was used for the first time in a retail setting in 1974. A native of New York, Laurer graduated from the University of Maryland in 1951 and spent 3 decades working for IBM. Accounts describe Laurer as an inveterate tinkerer, even up to his final years.

- **YOTA Month was a success in the Americas.** For the last several years, Youngsters on the Air (YOTA) has sponsored YOTA Month each December, primarily involving young radio amateurs in Europe and Africa. This past December, youth-operated amateur radio stations in the Americas picked up the ball to contribute more than 12,000 contacts to the worldwide total of some 129,000 contacts. In the US, 15 operators aged 25 or younger deployed special event 1 × 1 call signs — K8**Y**, K8**O**, K8**T**, and K8**A** — to call attention to the event and to youth in amateur radio. "My favorite part of YOTA Month was getting the wonderful experience of talking to other youth all over the world and sharing our experiences," said Audrey McElroy, KM4BUN. Her brother Jack, KM4ZIA, also took part.

Ray Hutchinson, AE6H, ae6h@soara.org

Public Service

Southern California Hams Deploy to Combat Wildfire Threats

Ray Hutchinson, AE6H, is an Orange County Fire Watch (OCFW) Team Leader, a retired Orange County Fire Authority (OCFA) Fire Captain, and the current president of the South Orange Amateur Radio Association (SOARA) based in Mission Viejo, California.

Wildfires with the resulting destruction of valuable watershed and timberlands, along with the potentially devastating loss of life, homes, and businesses, are a constant threat to the western US and many areas of the southeast. A dry, Mediterranean-type climate with frequent and pervasive periods of drought, coupled with steady seasonal wind events within vast areas of wild land, create an environment ripe for wildfire devastation. One southern California county has established a program to help combat this problem, employing ham radio volunteers as a key component. This effective program could serve as an inspiration and model for many other areas of the US, and even other parts of the world where wildfires constitute a significant threat.

Establishing a Fire Watch

Originally established in 2007 after several serious wildfires occurred in rapid succession, the Irvine Ranch Conservancy (IRC) in Orange County, California trained volunteer corps it had already established to work on other areas of conservation to help prevent and detect wildfire events. These trained volunteers were deployed during high fire danger weather conditions known as Red Flag Warnings. These events are declared by the National Weather Service (NWS) and are universally used throughout the fire service and other emergency response agencies for planning and staffing of enhanced activities and responses.

Two years later, the Orange County Board of Supervisors tasked the Orange County Parks Department (OCP) — which manages over 60,000 acres of wilderness parkland, open space, and shoreline — with devising a similar volunteer program.

Orange County Fire Watch (OCFW) ham volunteers Bill Frey, K6FRY, (left) and Ray Hutchinson, AE6H, (right) present wildfire prevention information at a public education event.

A study was conducted by the Orange County Fire Authority (OCFA) to determine and map the points of origin for hundreds of wildfires throughout the county. They found that over 90% of the ignitions occurred along major roadways and at points of entry to the wild land areas such as trailheads. They determined that 98% of these fires were the result of human activity, either by deliberate acts such as arson, or by accident.

Based on these studies, a plan was devised and implemented, consisting of a combination of educational programs, deterrence, and early detection. With hundreds of miles of susceptible roadways and numerous wild land entry points, already tight budgets were insufficient to provide the needed staffing to watch over these areas. Because the IRC and the OCP already had active volunteer programs in place, combining and expanding those volunteer programs solved the budget concern. Management of the program was then placed in the hands of the IRC (with heavy participation and support from OCP) and the Orange County Fire Watch (OCFW) organization was established.

Training and Deployment

Currently, the OCFW is directed by Tony Pointer, a full-time Program Manager employed by the IRC, and the program is a combined effort by the IRC, OCP, and OCFA agencies. The roster has over 360 trained volunteers, 53 of which are licensed amateur radio operators. These volunteers undergo a criminal background check and receive 3 days of training on topics that include dealing with the public and difficult persons, fire weather, wildfire behavior, reporting procedures, communications, and

personal safety. First aid and CPR training and certification is included. Upon satisfactory completion of training, volunteers are issued OCFW identification cards, uniform shirts and baseball caps, a first aid kit, a deployment manual, large vehicle identification magnetic door placards, and a distinctive high-visibility vest.

Joan Steiner, KJ6AIK, on OCFW deployment.

Whenever the NWS declares a Red Flag Warning for the Orange County weather zones, a cell phone call, text alert, and email is immediately sent by the program manager notifying volunteers of the OCFW deployment. Volunteers then go online to register for shifts at one of the 35 designated OCFW deployment locations, or to assist in the Operations Center. A Fire Watch Communications Net is established from the Operations Center via the South Orange Amateur Radio Association's (SOARA) high level 5,700-foot UHF repeater, which can be utilized by OCFW hams from all 35 deployment locations. Because of the many hills and topography of the canyon areas of the county, cellular service is not always available. Special care is taken to assign ham OCFW volunteers to remote locations with limited or no cell service. Fire watch ham volunteers report their current wind and weather conditions, as well as any other noteworthy but non-emergency occurrences. Emergencies are reported to 911 by the deployed volunteers, and then immediately to the Operations Center by radio. In areas with no cell service, emergencies are reported directly to the Operations Center by amateur radio for relay to 911.

Decreased Wildfires

Since the inception of the OCFW program, volunteers have dedicated over 18,000 hours to help prevent wildfires through public education, visible reminders, deterrence, and early detection. In 2018 alone, volunteers gave 3,333.5 hours to the program, including 12 days of Red Flag deployments, and 25 public education and outreach program presentations. Major partners in the OCFW program are the Orange County Parks, the Irvine Ranch Conservancy, and the Orange County Fire Authority. Other cooperating agencies include the NWS, SOARA, the Orange County Sheriff's Department, Orange County Radio Amateur Civil Emergency Services (RACES), Crystal Cove State Park, and the US Forest Service Cleveland National Forest.

Notably, with the establishment of the official Orange County Fire Watch program, the number and severity of wildfires in Orange County has been greatly reduced. While it's impossible to quantify the number of fires prevented, it's clear that the program has had a significant and beneficial impact. Groups or agencies who are interested in more information about how their jurisdictions might establish a similar program are welcome to contact OCFW Program Manager Tony Pointer at **tpointer@irconservancy.org**, or Ray Hutchinson, AE6H, at **ae6h@soara.org**. You may also visit **www.orangecountyfirewatch.org** for more information.

Field Organization Reports

December 2019

Public Service Honor Roll

This listing recognizes radio amateurs whose public service performance during the month indicated 70 or more points in six categories. Details on the program can be found at **www.arrl.org/public-service-honor-roll**.

494
WA7PTM

410
KD8TTE

371
W7PAT

365
N9VC

363
KE8BYC

325
WA3EZN

260
KW9EMG

237
AD8CM

235
W0PZD

230
WD8MWD

229
KD2LPM

228
WA2CCN

225
KT2D

206
K2RMF

205
KE8KOC

202
AL0Y

200
KK4PUX
W5DY

195
N8SY
WC9CW

190
K0IBS
AC0KQ

189
KV8LY

180
WB9WKO

168
WM2C

156
WS6P

155
W1RVY
N5MKY

153
W8IM
WB8RCR

150
KB3YRU
W4DNA

145
WO2H

144
WA2BSS

140
KY2MMM
KD8UUB
K4IWW
N4CNX

135
K9LGU
W3YVQ

130
WB9QPM
N2DW
WB8YYS
N2WGF
N2JBA
KW1U
K1XFC
NA7G

125
W3GWM
AG9G

124
KB5PGY
K3FAZ
KD2GXL

122
WD8USA

120
WA4VGZ
W4NWT
WC4FSU
K3JL
KY2D
W0LAW
KE5YTA
W7EES
WK4WC

119
KA9ZGY
KD8ZCM

117
W9GRG

115
NX9K
KC8WH

112
N3KRX

110
KA9MZJ
WB8YLO
N8CJS
KA5AZK
W1KX
K6HTN
AA3N
AA7BM
KD2JKV
N1IQI
K3IN
KA2ZNZ
KD2IWN
WA3QLW
WB8TQZ

106
KI4UDZ
KA5DON

105
K2TV
WF2Y

101
N3SW

100
NN7H

WB4RJW
KZ8O
WB7OSC
KN9P
AD3J
KB2QO
K3RC
AC8RV
WB8SIQ
KD2MDV
N1LAH
AA3SB
WB3FTQ
KB2YAA
K8ED

99
KC1HHO

96
KA2GQQ
K6JGL

95
KF5IOU
KB8RCR

93
K1HEJ

92
KG5NNA
W2CTG
K8RDN

90
KM4WHO
KD9EAQ
KC9FXE
K8LPC
K8KRA
N2TSO
W7PHX
KI7TIG
KB1NAL
WB8WKQ

89
KE1ML

88
N3RB
KB8HJJ
WD0BFO

85
W4TTO

84
W4INK
N2RQ
KB1NMO

83
K8AMH
N6IET

82
AD4DO
AB3WG
KA0DBK

81
K6JT

80
KB4CAU
KT4WX
KL7RF
KF7GC
WS4P

79
KN4AAG
K0FBS

77
W5XX
KC8YVF

76
K4VWK
WB8QLT
KC7ASA

75
KD2MEN

74
K3YAK

73
KA1G

72
KF4DVF

71
KV8Z
K8OV
KA2JFU

70
K6RAU

The following stations qualified for PSHR in previous months but were not reported in this column: (Nov.) WA7PTM 428, WS6P 213, WB7OSC 205, W2PH 170, WA2CCN 160, W4CMH 135, N1LL 130, KA9QWC 120, KA2ZNZ 110, KD2IWN 106, W9BGJ, W2PAX, K2RMF, KB2YAA 100, K9DUR 99, AB9ZA 91, WD0BFO, W9EEU 84, KA0DBK 83, WS4P 76, K6RAU 71.

Section Traffic Manager Reports

The following Section Traffic Managers reported: AL, AR, AZ, CO, CT, DE, EMA, EPA, IL, IN, LA, LAX, MDC, ME, MI, MN, MS, MT, NC, NE, NM, NNJ, NTX, NV, OH, OR, SC, SD, SFL, SJV, STX, TN, UT, VA, WMA, WI, WPA, WTX, WV, WY.

Section Emergency Coordinator Reports

The following Section Emergency Coordinators reported: AL, AR, AZ, CT, DE, ENY, EPA, EWA, GA, IA, IL, IN, KY, LA, ME, MDC, MI, MN, MO, MS, MT, ND, NFL, NLI, NM, NNJ, NV, OH, OR, PAC, SFL, SJV, SNJ, STX, SV, VA, VI, WNY, WPA, WTX, WV, WY.

Brass Pounders League

The BPL is open to all amateurs in the US, Canada, and US possessions who report to their SMs a total of 500 or more points or a sum of 100 or more origination and delivery points for any calendar month. Messages must be handled on amateur radio frequencies within 48 hours of receipt in standard ARRL radiogram format. Call signs of qualifiers and their monthly BPL total points follow.

KY2D 1265, NX9K 932, WB9WKO 724, K6HTN 574, N1IQI 605, KW1U 604.

Bruce Draper, AA5B, aa5b.corral@gmail.com

Contest Corral March 2020

Check for updates and a downloadable PDF version online at **www.arrl.org/contests**.
Refer to the contest websites for full rules, scoring information, operating periods or time limits, and log submission information.

Start - Date	Time	Finish - Date	Time	Bands	Contest Name	Mode	Exchange	Sponsor's Website
1	1200	1	1400	7	SARL Hamnet 40-Meter Simulated Emergency Contest	Ph	RS and serial	www.sarl.org.za
1	1200	1	2200	3.5	NSARA Contest	CW Ph Dig	RS(T), county (if NS)	nsara.ve1cfy.net/?page_id=82
1	1500	2	0059	3.5-144	North Carolina QSO Party	CW Ph Dig	NC county or SPC	ncqsoparty.org/rules
2	2000	2	2130	3.5	RSGB 80-Meter Club Championship, Data	Dig	RST, serial	www.rsgbcc.org/hf
3	0200	3	0400	3.5-28	ARS Spartan Sprint	CW	RST, SPC, power	arsqrp.blogspot.com
3	1900	3	2100	3.5	AGCW YL-CW Party	CW	RST, serial, name	agcw.org/index.php/en
4	2000	4	2100	3.5	UKEICC 80-Meter Contest	Ph	4-char grid square	www.ukeicc.com
5	1800	5	2200	28	NRAU 10-Meter Activity Contest	CW Ph Dig	RS(T), 6-char grid square	nrau.net/activity-contests
5	2000	5	2200	1.8-50	SKCC Sprint Europe	CW	RST, SPC , name, mbr or power	www.skccgroup.com
7	0000	8	2359	1.8-28	ARRL International DX Contest, SSB	Ph	W/VE: RS + SP. Non-W/VE: RS + power	www.arrl.org/arrl-dx
7	0000	15	2359	3.5, 7, 21, 28, 144	Novice Rig Roundup	CW	Name, QTH, rig and/or NRR number	www.novicerigroundup.org
7	0600	7	0800	7, 14	Wake-Up! QRP Sprint	CW	RST, serial, suffix of previous QSO	qrp.ru/contest/wakeup/333-wakeup-eng
7	1200	8	2359	1.8-50	SKCC Weekend Sprintathon	CW	RST, SPC, name, mbr or "none"	www.skccgroup.com
7	1800	8	1359	1.8-28	Open Ukraine RTTY Championship	Dig	2-letter region (state/province/ canton, etc.), serial	krs.ho.ua/openrtty
8	0700	8	1100	3.5	UBA Spring Contest, CW	CW	RST, serial, UBA section (if ON)	uba.be/hf/contest-rules
8	1800	8	2200	3.5	WAB 3.5 MHz Phone/CW	CW Ph	RS, serial, WAB square or country	wab.intermip.net
9	0000	9	0200	1.8-28	4 States QRP Group Second Sunday Sprint	CW Ph	RS(T), SPC, mbr or power	www.4sqrp.com
11	2000	11	2130	3.5	RSGB 80-Meter Club Championship, CW	CW	RST, serial	www.rsgbcc.org/hf
11	2300	15	2300	7, 14	AWA John Rollins Memorial DX Contest	CW	RST, equipment type and year	www.antiquewireless.org
14	0000	14	2359	3.5-28	YB DX RTTY Contest	Dig	RST, serial	rtty.ybdxcontest.com/dx-station-rules
14	1000	15	1000	3.5-28	RSGB Commonwealth Contest	CW	RST, serial	www.rsgbcc.org/hf
14	1200	15	1000	50, 70, 144 ,432, 1296	SARL VHF/UHF Analogue Contest	CW Ph	RS(T), 6-char grid square	www.sarl.org.za
14	1200	15	1200	3.5-144	F9AA Cup, SSB	Ph	RST, serial	www.site.urc.asso.fr
14	1200	15	1200	28	South America 10 Meter Contest	CW Ph	RS(T), CQ zone	sa10m.com.ar/cqsa10m_rules.html
14	1400	14	2000	3.5-28	AGCW QRP Contest	CW	RST, serial, class, mbr or "NM"	agcw.org/index.php/en
14	1500	15	1500	1.8	Stew Perry Topband Challenge	CW	4-char grid square	www.kkn.net/stew
14	1500	15	2100	3.5-50	Oklahoma QSO Party	CW Ph	RS(T), county or SPC	k5cm.com/okqp.htm
14	1600	15	1600	3.5-28	EA PSK63 Contest	Dig	RSQ, EA province or serial	concursos.ure.es/en
14	1800	15	0559	3.5, 7	TESLA Memorial HF CW Contest	CW	RST, serial, 4-char grid square	radiosport.org.rs/HFTeslaMemorial
14	1800	15	1800	1.8-50	QCWA QSO Party	CW Ph Dig	Last 2 digits of year first licensed, name, SPC or QCWA chapter	qcwa.org/W2020-qso-party-rules.pdf
14	1900	15	1900	1.8-28	Idaho QSO Party	CW Ph	County or SPC	pocatelloarc.org/idahoqsoparty
14	2200	14	2300	1.8-28	QRP ARCI Spring Thaw SSB Shootout	Ph	RS, SPC, mbr or power	qrparci.org/contests
15	0000	15	0400	3.5-14	North American Sprint, RTTY	Dig	Other station's call, your call, serial, name, SPC	ncjweb.com
15	0700	15	1100	144	UBA Spring Contest, 2 Meter	CW Ph	RS(T), serial, UBA section (if UBA)	uba.be/hf/contest-rules
15	1800	16	0100	All (no WARC)	Wisconsin QSO Party	CW Ph Dig	County or SPC	warac.org/wqp/wqp.htm
16	0200	16	0400	1.8-28	Run for the Bacon QRP Contest	CW	RST, SPC, mbr or power	qrpcontest.com/pigrun
16	1800	16	2059	3.5, 7	Bucharest Digital Contest	Dig	RST, serial	yo3test201x.blogspot.ro/p/blog-page.html
17	1700	22	1700	3.5-28	CLARA Chatter Party	CW Ph	RS(T), name, SPC	clarayl.ca/chatter-party
19	0030	19	0230	3.5-14	NAQCC CW Sprint	CW	RST, SPC, mbr or power	naqcc.info
21	0200	23	0200	3.5-28	BARTG HF RTTY Contest	Dig	RST, serial, 4-digit UTC time	www.bartg.org.uk
21	1200	22	1200	1.8-28	Russian DX Contest	CW Ph	RS(T), 2-char oblast or serial	rdxc.org/asp/pages/rulesg.asp
21	1400	21	1800	144, 432	AGCW VHF/UHF Contest	CW	RST, serial, power class, 6-char grid	agcw.org/index.php/en
21	1400	22	2359	All (no WARC)	Virginia QSO Party	CW Ph Dig	Serial, VA county or SPC	qsl.net/sterling/VA_QSO_Party
21	2000	21	2159	1.8-28	Feld Hell Sprint	Dig	RST, mbr, SPC, grid	sites.google.com/site/feldhellclub
22	0700	22	1100	3.5	UBA Spring Contest, SSB	Ph	RS, serial, UBA section (if ON)	uba.be/hf/contest-rules
25	0000	25	0200	1.8-28	SKCC Sprint	CW	RST, SPC, name, mbr or power	www.skccgroup.com
25	2000	25	2100	3.5	UKEICC 80-Meter Contest	CW	4-char grid square	www.ukeicc.com
26	2000	26	2130	3.5	RSGB 80-Meter Club Championship, SSB	Ph	RS, serial	www.rsgbcc.org/hf
28	0000	28	2359	1.8-VHF	FOC QSO Party	CW	RST, name, mbr (if FOC member)	g4foc.org/qsoparty
28	0000	29	2359	1.8-28	CQ WW WPX Contest, SSB	Ph	RS, serial	www.cqwpx.com
30	1300	31	0400	1.8-28	QCX Challenge	CW	RST, name, SPC, rig	qrp-labs.com/party.html

All dates refer to UTC and may be different from calendar date in North America. Times given as AM or PM are local times and dates. No contest activity occurs on the 60-, 30-, 17-, and 12-meter bands. Serial = Sequential number of the contact. S/P/C = State, Province, DXCC Entity. XE = Mexican state. Publication deadline for Contest Corral listings is the first day of the second month prior to publication date (May 1 for July *QST*) — send information to **contests@arrl.org**. Listings in blue indicate contests sponsored by ARRL or *NCJ*. The latest time for a valid contest QSO is the minute listed in the "Finish Time" column.

Bob Raymond, WA1Z, bobraymondwa1z@gmail.com

The 2019 IARU HF World Championship Results

Over 4,500 stations from all over the world participated in this popular contest, held July 13 – 14, 2019.

Marcin, HB9EGA, set up his portable station at a farm near his home in Switzerland. He finished first place in the Phone Only, QRP, World category. [Marcin Korona, HB9EGA, photo]

Full Results Online

You can read the full results of the contest online at **contests.arrl.org** or **www.arrl.org/contest-results-articles**. You'll find detailed analysis and more play-by-play, along with the full line scores. Improve your results by studying your log-checking report, too.

The next IARU HF World Championship will be held the second full weekend of July (July 11 – 12, 2020).

2019 IARU Special Station Scores

Scoring of IARU station logs provided by World Wide Radio Operators Foundation (WWROF).

IARU Headquarters Stations

Call	Score
TM0HQ	23,129,114
DA0HQ	18,751,986
OL9HQ	17,230,271
IO0HQ	17,195,076
EF4HQ	16,753,338
GR2HQ	16,658,376
S50HQ	16,025,672
SN0HQ	15,984,168
9A0HQ	14,913,108
LY0HQ	13,306,860
YT0HQ	11,799,399
YR0HQ	11,413,800
SE9HQ	11,269,009
LZ0HQ	10,040,744
OE0HQ	9,563,624
OP0HQ	9,530,523
NU1AW	8,674,050
HB9HQ	7,729,605
R9HQ	7,647,178
OZ1HQ	7,249,871
YL4HQ	6,597,450
PA6HQ	3,863,808
Z30HQ	3,658,341
8N0HQ	3,455,650
OH2HQ	3,385,440
LU0HQ	2,534,035
B0HQ	2,037,328
LN2HQ	1,958,094
CR5HQ	1,743,248
ER7HQ	1,376,090
W1AW	1,370,565
E2HQ	1,213,900
PJ2HQ	1,163,700
VP9HQ	1,128,420
CB1HQ	1,114,800
EI0HQ	1,068,480
CX1AA	782,132
A47HQ	777,650
T40HQ	699,985
TC3HQ	611,160
LX8HQ	608,420
UN1HQ	450,260
VR2HK	277,514
Z60A	253,616
DX0HQ	199,422
OA4O	141,000
HL0HQ	140,022
V31HQ	124,320
ZL6HQ	122,786
AT1HQ	116,730
EM5HQ	95,787
BV0HQ	95,404
YM1KM	150

IARU Administrative Council Stations

K1ZZ	2,403,393
G5W	2,298,785
LA2RR	1,612,416
VE6SH	86,152

IARU R1

F4GKR/P	761,971
DJ3HW	486,096
IV3KKW	109,710

IARU R2

YV5AM	1,415,458
KK1Z	1,170,606
VE3YV	25,428

IARU R3

JA1CJP	129,846
YB0AZ	80,104
9M4CMA	168

Top Ten — US and Canada

Single Operator, Mixed Mode, High Power

VE3EJ	2,284,035
NN3W (@N3HBX)	1,963,280
VE3AT	1,947,668
K5GN	1,857,288
NO6T (KI6RRN @WA6TQT)	1,779,844
VE3DZ	1,775,227
K5ZD	1,695,309
K6XX	1,307,580
K4AB	1,178,013
K3PA	1,035,090

Single Operator, Mixed Mode, Low Power

VA2EW	1,284,666
KD4D	929,940
W9PA (N9NB, op)	534,280
KU1CW	448,404
KU2M	406,077
VE3TG	197,613
N8II	149,688
WA2JQK	123,702
KM4HI	82,716
W1MJ	81,600

Single Operator, Mixed Mode, QRP

KJ4YM	792
N7JI	533

Single Operator, Phone Only, High Power

N1UR	1,032,624
W7WA	851,422
NA3D	378,696
KRØCKT	172,339
W6AFA	140,067
KD7RF	124,899
W5GFI	98,687
KE8FT	68,680
VA3ZNQ	57,904
W4BBT	44,240

Single Operator, Phone Only, Low Power

K6JO	200,376
N7MZW	34,419
VA3TPS	34,220
W8PDH	33,128
AB1EP	26,076
NE1D	24,612
VE1SQ	24,072
KN4EWI	19,796
N1XL	15,930
KR4NO	15,776

Single Operator, Phone Only, QRP

K5YM	6,270
WØJMW	1,683
VA3MYC	1,581
AD6OE	1,190
KEØRJE	360
VA3KXS	189
WA8ZIP	161
WD4IYE	80
KK7VL	52
WØHGW	3

Single Operator, CW Only, High Power

W1KM	2,080,806
VE3JM	2,016,214
K1KI	1,842,932
N2IC	1,507,099
W9RE	1,429,924
VE9AA	1,338,960
WXØB (AD5Q, op)	1,332,000
N4AF	1,187,970
W6YX (N7MH, op)	1,111,360
N3BB	1,083,664

Single Operator, CW Only, Low Power

KE5JSY (IZ3EYZ, op)	655,155
K4BAI	469,522
W1NN	468,860
WI2E	399,249
K7SV	358,827
WA1FCN	335,445
N8AA	329,749
KØAD	293,170
W1QK	280,876
WB4TDH	227,250

Single Operator, CW Only, QRP

K8CN	91,546
NE5TH	31,564
KEØTT	28,704
NU4B	16,377
W4QO	14,016
W5LA	9,396
AA1K	5,040
W6MZ	4,186
WR4I	3,528
W8DXU	3,120

Single Operator Unlimited, Mixed Mode, High Power

VA2WA	2,542,473
N8OO	1,669,269
VE5MX	1,503,675
NR3X (N4YDU, op)	1,471,259
K3WW	1,278,288
K7RL	1,195,922
N3QE	1,071,150
W1GD	1,015,992
K5CM (W5CW, op)	856,254
W3PU (KO8SCA, op)	800,976

Single Operator Unlimited, Mixed Mode, Low Power

NE9U	536,056
VA3DF	395,305
N5DO	279,020
W9AV	263,176
AA4LS	136,128
AC5O	114,635
W4EE	92,819
K1VU (N1EN, op)	81,760
KM4SII	81,508
VA3FF	81,445

Single Operator Unlimited, Mixed Mode, QRP

K8ZT	47,250

Single Operator Unlimited, Phone Only, High Power

KØBBC/VY2	762,908
W3LL	584,502
N8BI	339,146
WV4P	166,160
W3ICM	94,842
K4HDW	74,284
KC4NX	69,069
K4BBH	40,542
K1KP	40,432
N7GCO	36,120

Single Operator Unlimited, Phone Only, Low Power

K2ADA	123,732
WZ8T	59,954
KA2KON	55,650
WT8WV	32,984
KM4IAJ	22,680
K4ZMW	19,926
KI5MM	13,908
K4LDC	12,243
KA4FVE	11,395
KD2JOE	9,905

Single Operator Unlimited, CW Only, High Power

AA3B	2,729,188
K9CT	1,541,375
AB3CX	1,394,172
AD5A	1,213,315
N3AD	1,104,873
NT6Q (N5ZO, op)	985,704
N5RZ	797,886
VE3CX	738,375
N4BP	647,192
K6DAJ (@N6RO)	645,653

Single Operator Unlimited, CW Only, Low Power

W3KB	456,057
K9OM	428,672
VE3MGY	336,160
K6WSC	186,147
AB9YC	175,275
VE1RSM	157,000
W4PM	124,215
VE3MA	112,668
K2MK	108,924
K7TQ	85,960

Single Operator Unlimited, CW Only, QRP

K1KK (HK1A, op)	44,730
W1WBB	11,973
KU4A	11,628
KK7A	1,536
W4ER	1,122

Multioperator, Single Transmitter, High Power

K8AZ	1,769,888
K1IR	1,624,110
VE3UTT	1,504,140
WW4LL	1,428,820
NV9L	1,030,688
KT7E	849,028
W2Z	691,775
W4AQL	609,492
NØAX	593,700
VE9ML	589,680

Top Ten — Worldwide

Single Operator, Mixed Mode, High Power

CT9ABO (OM3GI, op)	4,881,184
RW7K	3,912,399
ES5RR (ES2RR, op)	3,245,047
UPØL (UN9LW, op)	2,901,816
EI7M (GD4XUM, op)	2,696,085
IR1G (IZ1LBG, op)	2,635,214
9A5Y (9A7DX, op)	2,605,913
OM3BH	2,574,558
DJ5MW	2,496,780
RM9I	2,387,154

Single Operator, Mixed Mode, Low Power

UW5Y (US2YW, op)	1,692,041
UW7LL	1,666,320
3V8SS (KF5EYY, op)	1,357,689
VA2EW	1,284,666
LY4L	1,211,760
R8CT	1,102,230
LZ1GU	994,560
UA4FER	962,795
KD4D	929,940
UA2K (UA2FB, op)	868,323

Single Operator, Mixed Mode, QRP

MM3AWD	564,120
LY5G	308,812
DF5RF	157,080
HG6C (HA6IAM, op)	149,668
HA5BA	149,375
UT5EOX	88,038
UX8IX	80,379
DK9BM	39,832
SP5PDA (SP5XSL, op)	38,098
EA6/DK5ON	30,889

Single Operator, Phone Only, High Power

YW1K (YV1KK, op)	1,042,448
N1UR	1,032,624
FY5FY	1,001,222
C4W (5B4WN, op)	996,224
W7WA	851,422
EA3CI	788,535
CR6K (CT1CJJ, op)	770,835
US5D (UT7DX, op)	752,854
OL8K (OK1GTH, op)	670,424
RM8A	551,754

Single Operator, Phone Only, Low Power

HA3DX (HA4XH, op)	766,475
ES6RW	664,196
IW1FRU	612,892
EI7T (ON4EI, op)	601,191
PA2TMS	390,051
UA3BL	263,520
OH6ECM	242,268
RC7KY	240,240
OE1HHB	222,824
K6JO	200,376

Single Operator, Phone Only, QRP

HB9EGA	59,964
SP9TKW	48,200
SP4LVK	38,522
UA3OQ	35,802
A61BK	31,949
HA1TI	24,108
UR7TV	17,500
PAØAWH	12,670
UA4ASE/6	7,654
K5YM	6,270

Single Operator, CW Only, High Power

KP2M (KT3Y, op)	2,580,048
UW1M (UR5MW, op)	2,323,620
R2DA	2,115,012
UR7GO	2,081,510
W1KM	2,080,806
VE3JM	2,016,214
K1KI	1,842,932
N2IC	1,507,099
HG5D (HA8QZ, op)	1,488,095
W9RE	1,429,924

Single Operator, CW Only, Low Power

UT5EO	1,389,406
HA1SN	1,202,630
8P5A (W2SC, op)	1,018,236
UA5F	832,656
WP3C	793,203
RX9AF	709,956
RW2F (RA2FA, op)	675,521
KE5JSY (IZ3EYZ, op)	655,155
RU9I	494,680
YL5W (YL2GN, op)	482,160

Single Operator, CW Only, QRP

DJ2RG	328,692
UY7RR	287,810
UR5FEO	192,696
R5PW	189,420
LZ5QZ	136,017
US5VX	131,968
S53AR	100,625
DM2DZM	98,600
K8CN	91,546
UZ7F	89,816

Single Operator Unlimited, Mixed Mode, High Power

HA3NU	3,255,408
LY7Z	3,098,073
VA2WA	2,542,473
TI7W (N3KS, op)	2,307,825
9A3XV	2,064,778
YL6W (YL2GD, op)	1,935,054
SO4M (SP5UAF, op)	1,716,534
RA6CA	1,711,640
G4R (YO4RDW, op)	1,707,552
UT5C (UX7CQ, op)	1,683,799

Single Operator Unlimited, Mixed Mode, Low Power

UZ3A (UX1AA, op)	1,738,659
HG1A (HA1ZN, op)	1,344,772
PC3T	1,191,380
9A1AA	1,166,418
UR6EA	1,076,865
OL5Y	1,031,680
RL6M	1,019,165
RU9AC	768,740
UW8SM	767,096
RV9UP	753,232

Single Operator Unlimited, Mixed Mode, QRP

DK3WE	720,434
EE3X (EA3KX, op)	409,479
PE2K	78,027
JG1LFR	56,525
K8ZT	47,250
7L3PFH	19,604
CM3EFM	4,896
3G3O (XQ3OP, op)	3,072
DL8MF	656
DM7C	66

Single Operator Unlimited, Phone Only, High Power

PT5J (PP5JR, op)	1,138,205
EF1W (EA1WS, op)	1,123,575
ED8W	1,030,682
HC5DBT	801,528
4Z7Z (4X1DX, op)	798,903
KØBBC/VY2	762,908
IR4K (IZ4JUK, op)	738,304
PJ4DX	658,392
RW3XZ	618,186
S54ZZ	607,168

Single Operator Unlimited, Phone Only, Low Power

HGØR (HAØNAR, op)	772,164
UR2Y (USØYW, op)	592,176
IK4LZH	585,984
EC5AN	569,245
YO7SR	317,275
RA9AU	271,660
DL4VAI	259,578
RZ3Z	251,868
F4VSE	234,252
TMØ7A	169,024

Single Operator Unlimited, Phone Only, QRP

HG6R	132,404
LZ1DM	54,320
9A4AA	31,680

Single Operator Unlimited, CW Only, High Power

P3X (UT5UDX, op)	4,255,180
SN7Q (SP7GIQ, op)	3,097,926
P44W (W2GD, op)	3,063,725
EA6FO (EC3TW, op)	2,732,136
AA3B	2,729,188
RT9A	2,553,985
UT4U (UT5UJO, op)	2,299,098
LY5E	2,262,960
YT6W	1,982,690
RL5A	1,811,244

Single Operator Unlimited, CW Only, Low Power

UT4LW	1,482,800
RU6K	1,470,574
5B/RN3QO	1,428,526
RC9A	1,419,704
SN7O (SP7IVO, op)	1,302,234
SP4JCQ	1,063,132
S53A	1,058,200
R7MM	1,031,955
4O3A (E77W, op)	898,367
RA3AN	820,328

Single Operator Unlimited, CW Only, QRP

RM5F	457,272
OK6K (OK5IM, op)	172,989
HG3C (HA3HX, op)	157,680
EU8F	144,329
ON3DI	140,580
IK2GWH	129,336
UT3EK	116,350
SMØLPO	104,448
LY3G	54,153
OK2AP	53,760

Multioperator, Single Transmitter, High Power

EF8R	8,941,053
RM9A	4,647,495
RL3A	4,521,984
UP2L	4,487,733
IR4M	3,875,095
IR4X	3,667,350
HG6N	2,858,128
EM2Q	2,457,216
OHØC	2,279,760
HG7T	2,147,866

Regional Leaders

Boxes list call sign, score, and class: MSHP = Multioperator, Single Transmitter, High Power; SO-CW-HP = Single Operator, CW Only, High Power; SO-CW-LP = Single Operator, CW Only, Low Power; SO-CW-QRP = Single Operator, CW Only, QRP; SO-MIX-HP = Single Operator, Mixed Mode, High Power; SO-MIX-LP = Single Operator, Mixed Mode, Low Power; SO-MIX-QRP = Single Operator, Mixed Mode, QRP; SO-PH-HP = Single Operator, Phone Only, High Power; SO-PH-LP = Single Operator, Phone Only, Low Power; SO-PH-QRP = Single Operator, Phone Only, QRP; SOU-CW-HP = Single Operator Unlimited, CW Only, High Power; SOU-CW-LP = Single Operator Unlimited, CW Only, Low Power; SOU-CW-QRP = Single Operator Unlimited, CW Only, QRP; SOU-MIX-HP = Single Operator Unlimited, Mixed Mode, High Power; SOU-MIX-LP = Single Operator Unlimited, Mixed Mode, Low Power; SOU-MIX-QRP = Single Operator Unlimited, Mixed Mode, QRP; SOU-PH-HP = Single Operator Unlimited, Phone Only, High Power; SOU-PH-LP = Single Operator Unlimited, Phone Only, Low Power, and SOU-PH-QRP = Single Operator Unlimited, Phone Only, QRP.

West Coast Region

(Pacific, Northwestern, and Southwestern Divisions; Alberta, British Columbia, and NT Sections)

NO6T (KI6RRN, op @WA6TQT)		
	1,779,844	SO-MIX-HP
K6XX	1,307,580	SO-MIX-HP
VE7UF (VE7JH, op)		
	780,710	SO-MIX-HP
W6TK	285,492	SO-MIX-HP
W6FB	77,175	SO-MIX-HP
KU1CW	448,404	SO-MIX-LP
W6RKC	47,250	SO-MIX-LP
AI6V	24,360	SO-MIX-LP
KE6GLA	10,465	SO-MIX-LP
VE6JF	9,196	SO-MIX-LP
N7JI	533	SO-MIX-QRP
W7WA	851,422	SO-PH-HP
KR0CKT	172,339	SO-PH-HP
W6AFA	140,067	SO-PH-HP
KD7RF	124,899	SO-PH-HP
KE8FT	68,680	SO-PH-HP
K6JO	200,376	SO-PH-LP
NF7E	15,004	SO-PH-LP
WB6CZG	7,854	SO-PH-LP
K6MUG	5,510	SO-PH-LP
NX7W (N7FLT, op)		
	3,528	SO-PH-LP
AD6OE	1,190	SO-PH-QRP
KK7VL	52	SO-PH-QRP
W6YX (N7MH, op)		
	1,111,360	SO-CW-HP
N6TV	858,888	SO-CW-HP
N6AA	617,760	SO-CW-HP
K7RAT (N6TR, op)		
	410,168	SO-CW-HP
VE7DZO	395,400	SO-CW-HP
WN6K	110,880	SO-CW-LP
K7HBN	54,020	SO-CW-LP
VA6WWW	41,268	SO-CW-LP
W6ZL	26,092	SO-CW-LP
K7AZT	14,858	SO-CW-LP
W6MZ	4,186	SO-CW-QRP
N6HI	1,360	SO-CW-QRP
N6HCN	784	SO-CW-QRP
K2GMY	636	SO-CW-QRP
VE7AHT	385	SO-CW-QRP
K7RL	1,195,922	SOU-MIX-HP
W9KKN	574,704	SOU-MIX-HP
NC6K	346,647	SOU-MIX-HP
N9NA	161,073	SOU-MIX-HP
N6IE	114,900	SOU-MIX-HP
K6GHA	79,876	SOU-MIX-LP
N7UJJ	22,776	SOU-MIX-LP
AE6PL	5,106	SOU-MIX-LP
AG6JA	1,972	SOU-MIX-LP
VE7BGP	984	SOU-MIX-LP
N7GCO	36,120	SOU-PH-HP
WZ8T	59,954	SOU-PH-LP
WA7YXY	5,012	SOU-PH-LP
W6RQ	1,472	SOU-PH-LP
KB7HDX	1,410	SOU-PH-LP
KI6SCT	234	SOU-PH-LP
NT6Q (N5ZO, op)		
	985,704	SOU-CW-HP
K6DAJ (@N6RO)		
	645,653	SOU-CW-HP
K6MMM (KE1B, op)		
	104,550	SOU-CW-HP
KC7EFP	103,050	SOU-CW-HP
W6RW	92,160	SOU-CW-HP
K6WSC	186,147	SOU-CW-LP
K7TQ	85,960	SOU-CW-LP
K7JQ	38,456	SOU-CW-LP
KN7K	21,552	SOU-CW-LP
KE7RW	8,085	SOU-CW-LP
KK7A	1,536	SOU-CW-QRP
KT7E	849,028	MSHP
K7RI	318,530	MSHP
K7BTW	311,680	MSHP
NX6T	295,254	MSHP
VA7DZ	92,748	MSHP

Midwest Region

(Dakota, Midwest, Rocky Mountain, and West Gulf Divisions; Manitoba and Saskatchewan Sections)

K5GN	1,857,288	SO-MIX-HP
K3PA	1,035,090	SO-MIX-HP
NG7M	77,436	SO-MIX-HP
W0ETT	73,186	SO-MIX-HP
WA5DSS	31,086	SO-MIX-HP
AE0EE	46,096	SO-MIX-LP
K0KR	44,184	SO-MIX-LP
KA8HDE	40,376	SO-MIX-LP
N9HDE	36,472	SO-MIX-LP
W0YJT	34,713	SO-MIX-LP
W5GFI	98,687	SO-PH-HP
K0VG	4,495	SO-PH-HP
K5TBA	4,059	SO-PH-HP
K5AVY	1,696	SO-PH-HP
K5TYR (WM5Q, op)		
	630	SO-PH-HP
N7MZW	34,419	SO-PH-LP
KM5JV	12,645	SO-PH-LP
AE0TT	10,990	SO-PH-LP
NW5Q	9,633	SO-PH-LP
W7KAM	8,460	SO-PH-LP
K5YM	6,270	SO-PH-QRP
W0JMW	1,683	SO-PH-QRP
KE0RJE	360	SO-PH-QRP
W0HGW	3	SO-PH-QRP
N2IC	1,507,099	SO-CW-HP
WX0B (AD5Q, op)		
	1,332,000	SO-CW-HP
N3BB	1,083,664	SO-CW-HP
W0UA	1,005,890	SO-CW-HP
WD0T	570,354	SO-CW-HP
KE5JSY (IZ3EYZ, op)		
	655,155	SO-CW-LP
K0AD	293,170	SO-CW-LP
NN5T	180,544	SO-CW-LP
W5RYA	151,715	SO-CW-LP
KG5U	136,152	SO-CW-LP
NE5TH	31,564	SO-CW-QRP
KE0TT	28,704	SO-CW-QRP
VE5/WB9QAF	780	SO-CW-QRP
KI0G	80	SO-CW-QRP
VE5MX	1,503,675	SOU-MIX-HP
K5GM (W5CW, op)		
	856,254	SOU-MIX-HP
N5JR	337,848	SOU-MIX-HP
K0KX	180,721	SOU-MIX-HP
K8LS	156,450	SOU-MIX-HP
N5DO	279,020	SOU-MIX-LP
KE5LQ	11,439	SOU-MIX-LP
NT5TT	2,618	SOU-MIX-LP
NA5J	2,496	SOU-MIX-LP
W0JWR	936	SOU-MIX-LP
WX0Z	4,864	SOU-PH-HP
K9TWW	546	SOU-PH-HP
KI5MM	13,908	SOU-PH-LP
KI5CXO	3	SOU-PH-LP
N0EO (AA0AW, op)		
	3	SOU-PH-LP
AD5A	1,213,315	SOU-CW-HP
N5RZ	797,886	SOU-CW-HP
N0AV	325,254	SOU-CW-HP
W0VX	141,327	SOU-CW-HP
WB0N	105,570	SOU-CW-HP
K0VBU	80,580	SOU-CW-LP
AD1C	55,877	SOU-CW-LP
K0MPH	20,102	SOU-CW-LP
NQ5M	12,274	SOU-CW-LP
K7ULS	3,933	SOU-CW-LP
N0AX	593,700	MSHP
W0ECC	329,324	MSHP
N0KE	21,888	MSHP
WA5LHM	21,600	MSHP
NM5M	8,556	MSHP

Central Region

(Central and Great Lakes Divisions; Ontario East, Ontario North, Ontario South, and Greater Toronto Area Sections)

VE3EJ	2,284,035	SO-MIX-HP
VE3AT	1,947,668	SO-MIX-HP
VE3DZ	1,775,227	SO-MIX-HP
K9ZO (WT2P, op)		
	720,945	SO-MIX-HP
WB8AKW	75,760	SO-MIX-HP
W9PA (N9NB, op)		
	534,280	SO-MIX-LP
VE3TG	197,613	SO-MIX-LP
VE3WRL	78,556	SO-MIX-LP
K4YJ	76,375	SO-MIX-LP
W8MET	74,108	SO-MIX-LP
VA3ZNQ	57,904	SO-PH-HP
AA8DC	37,128	SO-PH-HP
W9NZ	35,855	SO-PH-HP
N4ZY	23,058	SO-PH-HP
WB9ONU	10,455	SO-PH-HP
VA3TPS	34,220	SO-PH-LP
W8PDH	33,128	SO-PH-LP
WB9DAR	15,455	SO-PH-LP
VE3RVZ	14,850	SO-PH-LP
KV4ZY	12,402	SO-PH-LP
VA3MYC	1,581	SO-PH-QRP
VA3KXS	189	SO-PH-QRP
WA8ZIP	161	SO-PH-QRP
WD4IYE	80	SO-PH-QRP
VE3JM	2,016,214	SO-CW-HP
W9RE	1,429,924	SO-CW-HP
NA8V	1,061,632	SO-CW-HP
N8BJQ	466,900	SO-CW-HP
K8MP	289,192	SO-CW-HP
W1NN	468,860	SO-CW-LP
N8AA	329,749	SO-CW-LP
VE3TM	190,183	SO-CW-LP
KV8Q	128,610	SO-CW-LP
W8TM	110,134	SO-CW-LP
W8DXU	3,120	SO-CW-QRP
K8RJW	927	SO-CW-QRP
VE3RZ	580,920	SOU-MIX-HP
ND9G	403,550	SOU-MIX-HP
N2BJ	233,820	SOU-MIX-HP
VE3TW	129,708	SOU-MIX-HP
VE3MM	72,268	SOU-MIX-HP
NE9U	536,056	SOU-MIX-LP
VA3DF	395,305	SOU-MIX-LP
W9AV	263,176	SOU-MIX-LP
VA3FF	81,445	SOU-MIX-LP
K8GT	76,095	SOU-MIX-LP
K8ZT	47,250	SOU-MIX-QRP
N8BI	339,146	SOU-PH-HP
VA3WW	6,300	SOU-PH-HP
KC9WAV	3,726	SOU-PH-HP
VE3HED	2,736	SOU-PH-HP
KC9BG	2,124	SOU-PH-HP
WS6K	3,300	SOU-PH-LP
NR9K	2,349	SOU-PH-LP
VE3EZB	2,166	SOU-PH-LP
K9CT	1,541,375	SOU-CW-HP
VE3CX	738,375	SOU-CW-HP
VE3NZ	529,065	SOU-CW-HP
VE3NE	386,230	SOU-CW-HP
N9CO	370,944	SOU-CW-HP
K9OM	428,672	SOU-CW-LP
VE3MGY	336,160	SOU-CW-LP
AB9YC	175,275	SOU-CW-LP
VE3MA	112,668	SOU-CW-LP
WA9LEY	36,380	SOU-CW-LP
KU4A	11,628	SOU-CW-QRP
K8AZ	1,769,888	MSHP
VE3UTT	1,504,140	MSHP
NV9L	1,030,688	MSHP
K8AJS	260,414	MSHP
K9GX	108,819	MSHP

Southeast Region

(Delta, Roanoke, and Southeastern Divisions)

K4AB	1,178,013	SO-MIX-HP
K0EJ	862,040	SO-MIX-HP
N4PN	633,749	SO-MIX-HP
KU8E	431,680	SO-MIX-HP
N4NO	200,982	SO-MIX-HP
N8II	149,688	SO-MIX-LP
KM4HI	82,716	SO-MIX-LP
AA0O	65,424	SO-MIX-LP
N2JF	22,500	SO-MIX-LP
N4ARO	21,120	SO-MIX-LP
KJ4YM	792	SO-MIX-QRP
W4BBT	44,240	SO-PH-HP
KM3U	38,115	SO-PH-HP
WB4HRL	32,782	SO-PH-HP
KU4FX	20,237	SO-PH-HP
K4HWS	19,152	SO-PH-HP
KN4EWI	19,796	SO-PH-LP
N1XL	15,930	SO-PH-LP
KR4NO	15,776	SO-PH-LP
KM4ZQE	14,400	SO-PH-LP
K4SHW	12,240	SO-PH-LP
N4AF	1,187,970	SO-CW-HP
K3JT	443,784	SO-CW-HP
N2YO	212,534	SO-CW-HP
WQ5L	172,874	SO-CW-HP
AA4EA	141,732	SO-CW-HP
K4BAI	469,522	SO-CW-LP
K7SV	358,827	SO-CW-LP
WA1FCN	335,445	SO-CW-LP
WB4TDH	227,250	SO-CW-LP
K4OAQ	88,956	SO-CW-LP
NU4B	16,377	SO-CW-QRP
W4QO	14,016	SO-CW-QRP
W5LA	9,396	SO-CW-QRP
AA1K	5,040	SO-CW-QRP
WR4I	3,528	SO-CW-QRP
N8OO	1,669,269	SOU-MIX-HP
NR3X (N4YDU, op)		
	1,471,259	SOU-MIX-HP
WO4O	438,986	SOU-MIX-HP
N3UA	116,034	SOU-MIX-HP
WA4JUK	73,134	SOU-MIX-HP
AA4LS	136,128	SOU-MIX-LP
AC5O	114,635	SOU-MIX-LP
W4EE	92,819	SOU-MIX-LP
KM4SII	81,508	SOU-MIX-LP
WA4IPU	39,785	SOU-MIX-LP
WV4P	166,160	SOU-PH-HP
K4HDW	74,284	SOU-PH-HP
KC4NX	69,069	SOU-PH-HP
K4BBH	40,542	SOU-PH-HP
KM4VTE	26,962	SOU-PH-HP
K2ADA	123,732	SOU-PH-LP
WT8WV	32,984	SOU-PH-LP
KM4IAJ	22,680	SOU-PH-LP
K4ZMW	19,926	SOU-PH-LP
K4LDC	12,243	SOU-PH-LP
N4BP	647,192	SOU-CW-HP
W4NZ	640,840	SOU-CW-HP
K3IE	517,960	SOU-CW-HP
K2SX	445,354	SOU-CW-HP
N1LN	385,320	SOU-CW-HP
W4PM	124,215	SOU-CW-LP
K2MK	108,924	SOU-CW-LP
N4UW	78,624	SOU-CW-LP
AA4NP	56,304	SOU-CW-LP
N4TP (W4LT, op)		
	47,694	SOU-CW-LP
K1KK (HK1A, op)		
	44,730	SOU-CW-QRP
W4ER	1,122	SOU-CW-QRP
W4AQL	609,492	MSHP
N4IQ	422,433	MSHP
K4OV	397,075	MSHP
W0NA	265,727	MSHP
W4UAL	40,651	MSHP

Northeast Region

(New England, Hudson, and Atlantic Divisions; Maritime and Quebec Sections)

NN3W (@N3HBX)		
	1,963,280	SO-MIX-HP
K5ZD	1,695,309	SO-MIX-HP
K3ZO	697,026	SO-MIX-HP
N3XF	124,832	SO-MIX-HP
KM2L	61,710	SO-MIX-HP
VA2EW	1,284,666	SO-MIX-LP
KD4D	929,940	SO-MIX-LP
KU2M	406,077	SO-MIX-LP
WA2JQK	123,702	SO-MIX-LP
W1MJ	81,600	SO-MIX-LP
N1UR	1,032,624	SO-PH-HP
NA3D	378,696	SO-PH-HP
KK1L	37,092	SO-PH-HP
W2KU	8,304	SO-PH-HP
KD2NE	7,194	SO-PH-HP
AB1EP	26,076	SO-PH-LP
NE1D	24,612	SO-PH-LP
VE1SQ	24,072	SO-PH-LP
N2MTG	14,307	SO-PH-LP
N3XZ	13,255	SO-PH-LP
W1KM	2,080,806	SO-CW-HP
K1KI	1,842,932	SO-CW-HP
VE9AA	1,338,960	SO-CW-HP
K1IMI (N4CW, op)		
	484,484	SO-CW-HP
VA1MM	334,866	SO-CW-HP
WI2E	399,249	SO-CW-LP
W1QK	280,876	SO-CW-LP
K2ZR	146,740	SO-CW-LP
N1QY	136,080	SO-CW-LP
W2IY	105,448	SO-CW-LP
K8CN	91,546	SO-CW-QRP
WA2NYY	1,482	SO-CW-QRP
VA2WA	2,542,473	SOU-MIX-HP
K3WW	1,278,288	SOU-MIX-HP
N3QE	1,071,150	SOU-MIX-HP
W1GD	1,015,992	SOU-MIX-HP
W3PU (KO8SCA, op)		
	800,976	SOU-MIX-HP
K1VU (N1EN, op)		
	81,760	SOU-MIX-LP
AA1SU	28,762	SOU-MIX-LP
VE2CJR	24,924	SOU-MIX-LP
W3FIZ	13,631	SOU-MIX-LP
WA1DRQ	12,358	SOU-MIX-LP
K0BBC/VY2	762,908	SOU-PH-HP
W3LL	584,502	SOU-PH-HP
W3ICM	94,842	SOU-PH-HP
K1KP	40,432	SOU-PH-HP
N2MUN	17,424	SOU-PH-HP
KA2KON	55,650	SOU-PH-LP
KD2JOE	9,905	SOU-PH-LP
W2JV	7,955	SOU-PH-LP
N3YPJ	5,421	SOU-PH-LP
VE9WRS	4,396	SOU-PH-LP
AA3B	2,729,188	SOU-CW-HP
AB3CX	1,394,172	SOU-CW-HP
N3AD	1,104,873	SOU-CW-HP
K4RUM	622,870	SOU-CW-HP
N3RS	588,093	SOU-CW-HP
W3KB	456,057	SOU-CW-LP
VE1RSM	157,000	SOU-CW-LP
N3ZA	30,976	SOU-CW-LP
WA3MD	25,830	SOU-CW-LP
AC3BU	20,352	SOU-CW-LP
W1W8B	11,973	SOU-CW-QRP
K1IR	1,624,110	MSHP
WW4LL	1,428,820	MSHP
W2Z	691,775	MSHP
VE9ML	589,680	MSHP
W3ZGD	329,160	MSHP

Maty Weinberg, KB1EIB, events@arrl.org; www.arrl.org/special-event-stations

Special Event Stations

Working special event stations is an enjoyable way to help commemorate history. Many provide a special QSL card or certificate!

Through Dec. 31, 0000Z – 2359Z, various call signs, various cities, IA. Great River Amateur Radio Club. **Iowa State Parks On-the-Air Centennial Celebration**. All bands, all frequencies, as available. Certificate & QSL. IASPOTA-2020, c/o Great River Amateur Radio Club, P.O. Box 1384, Dubuque, IA 52004. *Members will operate with their own call signs from state parks throughout Iowa. Operating as time permits, mostly weekends. QSL for single contact; contact five parks for a certificate. See website for complete information.* **www.w0dbq.org/iaspota**

Feb. 1 – Feb. 29, 0001Z – 2359Z, II3BIA, Antholz, South Tyrol, Italy. ARI Sektion Bruneck. **Biathlon World Championships 2020**. CW, SSB, and digital; 160, 80, 40, 20,15,10, 2 meters; 70 centimeters; 23 centimeters satellite Es'Hail 2 QO-100. QSL. Via bureau or direct to: ARI Sektion Bruneck, Montal 25, 39030 Bruneck/St. Lorenzen, Italy. **www.ari-bruneck.com**

Feb. 29, 0000Z – 2359Z, WA4CZD, Sparta, TN. **2019 Rare Disease Day Special Event**. 14.246 7.246 7.115. QSL. Via bureau, LoTW, or direct to Jill Dybka, WA4CZD, 7737 Sparta Hwy., Sparta, TN 38583.

Mar. 1, 1300Z – 2300Z, N0N, Lincoln, NE. Southeast Nebraska Amateur Radio Club. **Nebraska Statehood Day**. 18.150 14.292 14.265 7.180. Certificate & QSL. Charles Bennett, KD0PTK, P.O. Box 67181, Lincoln, NE 68506. *We will be operating from the 14th floor of the State Capitol building. Clubs across Nebraska are encouraged to participate.* **https://www.facebook.com/SENRC**

Mar. 5 – Mar. 12, 0000Z – 0000Z, W5S, Oklahoma City, OK. Mid-Del Amateur Radio Club. **C-47 Skytrain**. 144.200 14.280 7.280. QSL. Mid-Del Amateur Radio Club, P.O. Box 30512, Midwest City, OK 73140. **www.w5mwc.org**

Mar. 14, 1300Z – 1900Z, W1M, Russell, MA. Western Mass Council — Scouting USA. **WHOA/SCOTA**. 14.290 14.060 7.190 7.030. QSL. Tom Barker, 329 Faraway Rd., Whitefield, NH 03598. *Paper logging is used; there will be a delay in sending out QSL cards.*

Mar. 14, 1600Z – 2100Z, K7T, Tucson, AZ. Oro Valley Amateur Radio Club. **Battle of Picacho Peak Anniversary**. CW 14.040 7.040; SSB 14.250; FT8 18.100. Certificate. Email **qsl@tucsonhamradio.org** for certificate. *No paper QSLs please.* **www.tucsonhamradio.org**

Mar. 14, 1700Z – 2300Z, K9TAL, Indianapolis, IN. The American Legion Amateur Radio Club. **The American Legion's 101st Birthday Celebration**. 14.275 7.225; *CrossRds* EchoLink Conference IRLP Reflector 9735. Certificate & QSL. The American Legion Amateur Radio Club, 700 N. Pennsylvania St., Indianapolis, IN 46204. **k9tal@legion.org** *or* **www.legion.org/hamradio**

Mar. 14, 1700Z – 2359Z, NI6IW, San Diego, CA. USS *Midway* (CV-41) Museum Ship. **Launching of USS *Midway***. 14.320 7.250 PSK31 14.070 DSTAR REF001C. QSL. USS *Midway* Museum Ship COMEDTRA, 910 N. Harbor Dr., San Diego, CA 92101.

Mar. 14 – Mar. 15, 0500Z – 0500Z, N2RE, Princeton, NJ. David Sarnoff Radio Club. **Pi Day March 14, 2020**. 14.250 14.050 7.120 7.050. QSL. Bob Uhrik, 104 Knoll Way, Rocky Hill, NJ 08553-1013. **www.qrz.com/db/n2re**

Mar. 16 – Mar. 22, 0000Z – 2359Z, K1B/K1J/K1P/W1C/W1H/W1K/W1L/W1O/W1P/W1S/W1W/W1Y, various cities, ME. Maine Bicentennial Special Event Group. **Maine Bicentennial Special Event**. HF, 6 and 2 meters; SSB, CW, and digital. Certificate. Tim Watson, KB1HNZ, P.O. Box 6833, Scarborough, ME 04074. *Certificate for contact; endorsements for bands, modes, and clean sweep of contact with each of the Maine 200 special event call signs.* **maine200specialevent.com**

Mar. 20 – Mar. 31, 0000Z – 2359Z, N6A, Healdsburg, CA. Will Pattullo, AE6YB. **Alcatraz Federal Penitentiary Anniversary of Closing**. 21.265 14.265 7.265 3.815. QSL. Will Pattullo, 161 Presidential Cir., Healdsburg, CA 95448. **www.qrz.com/db/ae6yb**

Mar. 24 – Mar 26, 1300Z – 2000Z, W4LX, Fort Myers, FL. Fort Myers Amateur Radio Club. **The Buckingham Army Airfield**. 21.240 14.240. Certificate & QSL. Fort Myers Amateur Radio Club, P.O. Box 061183, Fort Myers, FL 33906. **www.fmarc.net**

Mar. 28, 1400Z – 2000Z, W4BKM, Macon, GA. Macon Amateur Radio Club. **Cherry Blossom Special Event Station**. 14.240 7.225. Certificate. Macon Amateur Radio Club, P.O. Box 4682, Macon, GA 31208. **www.w4bkm.org**

Mar. 29, 1400Z – 2100Z, N4H, Daviston, AL. Lake Martin Amateur Radio Club. **Battle of Horseshoe Bend (Creek Indian War) Anniversary**. 14.250 7.280 3.850. Certificate & QSL. John Philips, P.O. Box 938, Alexander City, AL 35011. **www.facebook.com/K4YWE/** *or* **www.qrz.com/db/n4h**

Certificates and QSL cards: To obtain a certificate from any of the special event stations offering them, send your QSO information along with a 9 × 12-inch self-addressed, stamped envelope (three units of postage) to the address listed in the announcement. To receive a special event QSL card (when offered), be sure to include a self-addressed, stamped business envelope along with your QSL card and QSO information. *Note: Some clubs may ask for a nominal fee to cover the cost of the certificate or QSL. Request will be made on air during the event or on the club's website.

Special Events Announcements: For items to be listed in this column, use the ARRL Special Events Listing Form at **www.arrl.org/special-events-application**. A plain-text version of the form is available at that site. You may also request a copy by mail or email. Off-line completed forms can be mailed, faxed (Attn: Special Events), or emailed.

Submissions must be received by ARRL HQ no later than the 1st of the second month preceding the publication date; a special event listing for **June** *QST* would have to be received by **April 1**. In addition to being listed in *QST*, your event will be listed on the ARRL Web Special Events page. Note: All received events are acknowledged. If you do not receive an acknowledgement within a few days, please contact us. ARRL reserves the right to exclude events of a commercial or political nature.

You can view all received Special Events at **www.arrl.org/special-event-stations**.

Jon Jones, NØJK, n0jk@arrl.org

The World Above 50 MHz

VHF Antennas and Geminids Activity

Figure 1 — Rick Dorsch's, NE8Z, setup while operating on 6 meters from Ecuador in fall 2019. [Rick Dorsch, NE8Z, photo]

Antennas for the 222 MHz band are straightforward and easier to manage, as they are smaller than on 144 MHz. The Yagi is the most popular design for weak-signal work. Vendors such as M2 and Directive Systems offer quality antennas. For the DIY enthusiast, design options include the WA5VJB Cheap Yagi (found at **https://www.wa5vjb.com/yagi-pdf/cheapyagi.pdf**) and the VE3CVG "Plumber's Delight" 222 MHz Yagi (found at **https://ve3cvg.webqth.com/antennas/222/index.html**). Another antenna to consider is the Quagi (found at **www.overbeck.com/quagi.htm**). I used a Quagi on 222 MHz for years. It is an effective and inexpensive antenna if one takes care during construction.

HC1MD/2 6-Meter Activity from Ecuador

Rick Dorsch, NE8Z, says he operated the first week in November 2019 from the Capay on Hill Lighthouse in Ecuador (World Lighthouses on the Air reference number WLOTA ECU-017). Rick recalled when he operated as HC1MD/5 on 6 meters working TEP in Solar Cycle 23 (see Figure 1). But he didn't have a 6-meter antenna. Rick improvised, saying:

> I wandered down to the maintenance shed and had the worker scrounge up some material for me. We found an old PVC pipe. He made three insulators for me and drilled the necessary holes for an inverted-V antenna for 50 MHz. We found an old 20-foot scrap piece of #14 stranded wire. I didn't have solder or a soldering gun with me. I cut the wire to 50.200 MHz and then tightly wrapped the wire around the end of a PL-259 connector (I had a 25-foot length of RG8-X with PL-259s in my suitcase as a spare). I taped it really tight and then mounted the antenna my balcony hanging 30 meters from the cliff over the Pacific Ocean.

After setting up the antenna, Rick called one CQ on 50.313 MHz on FT8 on November 1, 2019 at 2158Z, running 50 W.

"My entire screen lit up orange!" Rick recalled as he began working through the pileup. From 2158Z – 2337Z, he made contacts with 12 stations. Rick says KD5M copied every CQ he sent that afternoon. "It was like we had a wire running between us." From 0001Z until 0020Z on November 2, Rick worked W5RWF (EM50) , WD5BJT, AA5C (EM13), and W5TCX (EL29). Later that same day, from 2048Z until 2116Z, Rick "worked YS1MAE, TI5/N5BEK, and ZF1EJ." Rick felt the propagation mode was TEP.

Following the opening on DX Maps, I saw sporadic E present from the southeast states, Gulf Coast, and Texas to Central America. Ecuador is within double-hop sporadic-E range of these regions, and perhaps it was E_s.

If the HC8GR/b had been operational, it may have let 6-meter DXers know if the Galapagos Islands were included in this unexpected opening.

On the Bands

50 MHz. The Winter North America sporadic-E season started off with a bang on December 4, with a strong all-day opening across North America, extending to Central America and the Caribbean. E_s first appeared from W5 and W8 at 1405Z, then spread across eastern North America. I made dozens of FT8 E_s contacts to Alabama, Georgia, and Florida from EM28 around 1830Z. Later, I stopped on highway 177 south of Manhattan, Kansas (EM18), and set up fixed mobile. I used an MFJ-9406 at 10 W and ¼-wave magnet mount. I made seven FT8 contacts in Florida, Georgia, and Virginia. I was called by WA1EAZ (FN42) and decoded WU1ITU (FN65) on 2× E_s. NØLL (EM09) decoded HH2AA. KW4BY in Florida also spotted some DX stations, including TI5/N5BEK, XE1MEX, XE2AT, XE2JS, HI8DL, HI8PLE, KP4EIT, HI8RD, NP3XF, NP4BM, and LU5FF on E_s – TEP. Roger, VE1SKY (FN74), made 19 contacts on sporadic E using FT8. The next day, he made 41 FT8 E_s contacts in the southeast states.

Roger, VE1SKY, completed a Geminids MSK144 contact with WØVTT (EN33), and at 1406Z, Roger decoded W5LDA, working W4VAS.

They ran a schedule, and at 1432Z, W5LDA received a "R FN74" message from VE1SKY, but there was no completion. The distance was 2,776 kilometers.

Larry, NØLL, operated portable from rare grid EN20 during the Geminid meteor shower, running 60 W and a three-element Yagi. During the shower, Larry made 24 MSK144 contacts (including NØJK in EM28 at 1412Z on December 14). His best DX contact was with WA1EAZ (FN42) "on a blue whizzer." Larry decoded several stations on his mobile whip while driving to the operating site.

Bob, K6QXY, reports working A21NK (Paul, ZS6NK) on December 15 on JT65 EME for his 184th 6-meter DXCC contact at –27 dB.

On December 20, there was a North America-to-New Zealand opening. Gary, K9RX (EM84), in South Carolina, heard and then worked ZL4RV at 2159Z using JT65. A few minutes later, he added ZL4AS with a –13 dB report. There was E_s present from the southeast states to Mexico as well as ZL stations, working XE1MEX at this time. XE1MEX reported working ZL3RC, ZL4RV, ZL3NW, and ZL2OK. Perhaps E_s links from North America across afternoon TEP, then via E_s to New Zealand. These were truly remarkable contacts at the solar minimum on 6 meters.

144 MHz. NØLL (EM09) worked K7ULS (DN41) on MSK144 on December 2 at 1434Z. KFØM (EM17) worked KØTPP (EM48) on tropo on December 7. WA9DU (EM69) logged VE1SKY (FN74) via MSK144 on December 9 at 1347Z. David commented:

> The *WSJT* modes have truly altered the landscape on the ultra highs. Throw in the chat rooms and some of the other software… and the situation is way different. There has never been a better time to be active on VHF/UHF. The tools available today are so much better than in the past. While much has changed, the one thing that hasn't is that thrill of snagging a new one.

On December 26, Ray, W3BFC (FM28), worked KG4HJB (EL98) on tropo. W3BFC was using a single-loop antenna and 85 W on SSB. On December 28, Stan, W8MIL (EN74), found midday tropo to New Jersey and New York. He worked AA2UK, KC2TN (FM29), and K2KV (FN20), all on SSB.

222 MHz. Wyatt, ACØRA, and KG5CCI ran a grid expedition to Arkansas and Oklahoma on 222 MHz during the Geminids. They completed 15 contacts, 13 via MSK144 and two on FT8 (see Figure 2). The best DX contact was with K1OR (FN42). Charles, NØAKC (EN44), worked the pair in both states on MSK144. Oklahoma is his 20th state.

Figure 2 — Dave, KG5CCI, and Wyatt, ACØRA, on their 2019 Geminid meteor shower operation on 222 MHz from Arkansas and Oklahoma. [Wyatt Dirks, ACØRA, photo]

K7ULS (DN41) also got both rare states on MSK144. James, K7KQA (DN06), picked up W9RM (DM58) and N1AV (DM43) in the Geminids. He runs a seven-wave-long Yagi.

432 MHz. Bob, K2DRH (EN41), noted tropo associated with unseasonably warm weather in the Midwest on December 24/25. He worked Brad, WQ5S (EM13), from 1,145 kilometers and Al, W5LUA (EM13), using FT8.

Here and There

Lance, W7GJ, and Gene, KB7Q, announced a joint 6- and 2-meter EME DXpedition to the Marquesas November 3 – 15, 2020, as TX7MB. For more information, visit **www.bigskyspaces.com/w7gj/Marquesas%202020.htm**.

According to **spaceweather.com** reports, more sunspots from Solar Cycle 25 are appearing on the first week of January. Unfortunately, this does not mean the solar minimum is ending. Low sunspot counts will continue for years. But Solar Cycle 25 is coming to life!

Al Rovner, K7AR, k7ar@arrl.net

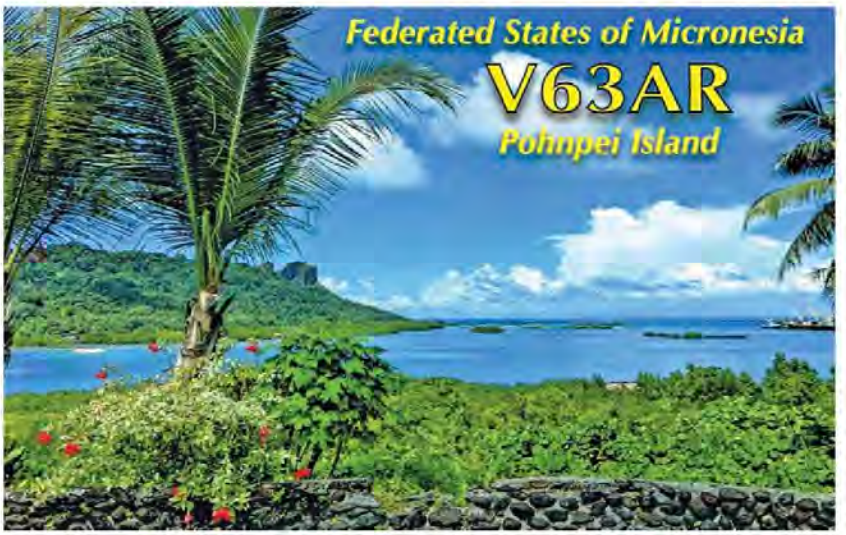
How's DX?

The *WSJT-X* Call 1st Setting

Al is a frequent traveler to the Pacific. In this month's column, he discusses his experience with WSJT-X*'s Call 1st setting during his recent operation as V63AR.*

In this column, I'll explain the Call 1st setting in *WSJT-X*. I'll provide specific scenarios of use by covering three ways a DXpedition manages an FT8 pileup and the pros and cons of each method.

Figure 1 shows the Call 1st checkbox with the tooltip, "Check to call the first decoded responder to my CQ." While operating as V63AR, I worked stations three ways on FT8: Fox/Hound mode, Call 1st unchecked, and Call 1st checked.



QSL cards from Al Rovner's, K7AR, 18 – 26, 2019 operation can be obtained via K7AR using Club Log's Online QSL Request System (OQRS) for both direct or bureau requests.

Figure 1 — The Call 1st checkbox tooltip.

Fox/Hound Mode

When calling CQ on a standard FT8 frequency, usually within a few minutes the pileup becomes large enough to warrant using Fox/Hound mode. Fox/Hound mode allows all stations calling the expedition to have the chance for a contact as long as the DX operator places stations in the Fox queue in the order they are received. Each station in the queue bubbles to the top as other stations are worked, and has three opportunities to complete a contact. If a contact cannot be completed, the station is dropped from the queue, making room for other stations.

Call 1st Unchecked

Sometimes a band isn't open or there are not enough callers to warrant using Fox/Hound mode. In this case, I would call CQ on a standard FT8 frequency, and manually pick stations to reply to from the list of decoded stations. As I have operated from the Pacific for the last 6 years, I've found that stations from Asia are booming on all bands. While it's easy to have contacts with Japan (JA), China (BY), South Korea (HL), Asiatic Russia (UA0), and other Asian stations, sometimes I'll manually select those with a more difficult path to the Pacific, such as the US East Coast, western European Union, or southern Africa. My location at V63AR is almost 10,000 miles from South Africa (ZS), so it was a pleasure to have contacts with those stations. It's really up to the DX operator on how to handle this situation.

Call 1st Checked

A real-world example of a checked Call 1st box is shown in Figure 2. Just below the first yellow line in the figure, YC2WXV is calling on 488 Hz, and is the lowest frequency calling. Therefore, it meets the Call 1st criteria as a completed contact.

The fact that Call 1st responds automatically to stations on lower frequencies first makes it challenging for stations calling at higher frequencies to make contacts. There are two ways to handle this.

For the first method, see Figure 2. Notice JI2FBG at 606 Hz below the second yellow line. That is not present in the previous section with red decoded signals. By calling at 606 Hz, this station jumped ahead of other callers, becoming the next contact made.

The second method is to call on the DX station's frequency. In the case of Figure 2, that would be 1060 Hz. This allows a station to immediately get through to the DX station, bypassing Call 1st. However, if five stations call on 1060 Hz, it's possible for no one to be decoded. In fact, most FT8 operators are taught to avoid calling on the DX station's frequency.

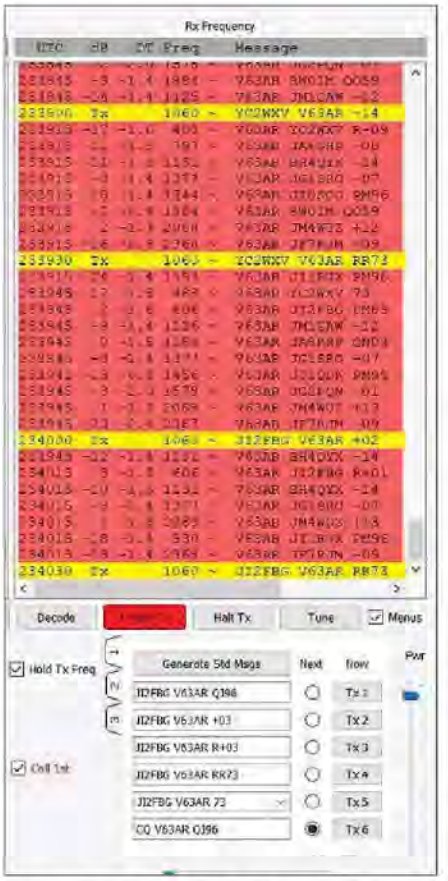


Figure 2 — An example of several stations calling V63AR, ordered by frequency.

Now, I'm not necessarily saying you should start calling DX stations at 300 Hz or lower to be first on the decoded list, but this can be a tricky situation. From your home station, you have no way to know whether a DX station is using the Call 1st mode. In Figure 2, all stations are nicely lined up on different frequencies, hoping for a contact.

Finding the Right Fit

I suggest implementing a Call Random mode. This would give all callers an opportunity to have a contact, regardless of what frequency they use. Call Random would randomly choose a station from the list of decoded signals and proceed with a contact.

While my comments are from the perspective of a DXpedition operator, they also apply to home stations. Next time you call CQ on FT8, consider how Call 1st mode works, and whether it's right for you.

All photos by the author.

The April 2020 ARRL Rookie Roundup — Phone

1800 UTC – 2359 UTC, Sunday, April 19

The Rookie Roundup is an event to encourage newly licensed operators to get on the HF bands and experience competitive amateur radio. This is a great way for clubs to get their newer members on the air, and the perfect opportunity to mentor new licensees.

Rookies will attempt to make as many contacts as possible during this 6-hour event. Rookies work everyone and non-Rookies work only Rookies. If you were first licensed in 2020, 2019, or 2018, you can enter as a Rookie.

Rookie entries are limited to operators who have either:

- Made no contacts at all or have made their first amateur radio contact during 2020, 2019, or 2018;
- Or, for this event, who have never made any contacts on the phone contest mode before the Rookie Roundup contest. Operators may enter in this category only once and must send the current year in their exchange.

Participants in the Rookie Roundup can receive certificates to proudly display their achievements. Results and certificates will be available at **contests.arrl.org**.

Rookies can enter as Single Operators or invite Rookie friends over and operate as Multioperator. Up to five Single Operator Rookies can also enter from their individual stations and submit their total score as a team.

The exchange is your name, the last two numbers of the year you were licensed, and your state, province, or "DX" if you're outside of the US and Canada.

Non-Rookies, join the fun by calling "CQ Rookies," to encourage the Rookie operators to flock to you.

All scores must be reported within 72 hours after the event. No late entries will be accepted.

Complete rules, log sheets, and links for submitting your score can be found at **www.arrl.org/rookie-roundup**.

Complete rules can be found at **www.arrl.org/rookie-roundup**

Certificate of Code Proficiency

Recipients

Sponsored by VIBROPLEX
www.vibroplex.com

This month, ARRL and Vibroplex recognize merit and progress in Morse code proficiency on the part of the following individuals, who have achieved proficiency at the following rates, in words per minute.

November 2019

David A. Bamford, W2DAB	10
Michael J. Erskine, W4MHZ	10
Mark G. Feuerstein, N7MMO	10
John F. Johnson, N8JFJ	10
Michael W. Geoghegan, KX6A	10
Donald E. Kirby, KR3A	10
William A. Miller, W6QA	10
James D. Russ, AB4KA	10
Warren T. Seeley, W4FLL	10
Richard P. West, KH2EE	10
Stephen P. White, KL3MM	10
David J. Wise, KD6EOD	10
Frank P. Arciuolo, W1ZAH	15
Keith Austermiller, KB9STR	15
Michael J. Erskine, W4MHZ	15
Paul W. Peterson, K1HIS	15
John F. Wasciuk, WA8TON	15
Stephen M. Zappe, WA3GQA	15
Joe P. Bratton, AA5AD	20
Raymond T. Henderson, WA3PRR	20
Michael Terry Jones, W4TL	20
Roy S. Ludwig, KN4WOJ	20
Stephen J. Mlecik, K1NA	20
Akihiro Akai, JQ2UOZ	25
Donald J. Backys, K9UQN	25
Michael Terry Jones, W4TL	25

December 2019

Thomas P. Baxter, W9TPB	10
Benjamin M. Cahill, III, AC2YD	10
James T. Griffin, N4JG	10
Martin Hickey, AJ6CL	10
Steve M. Kuzyszyn, KB2WQ	10
Willis S. Stricklin, KØSMK	10
Gerald E. Trimble, Jr., KG8HZ	10
Paul Leon Castonguay, KC1LBL	15
Cesidio DiBenedetto, Jr., KD8OOB	15
Steven G. Fein, KM6VOV	15
Paul A. Miller, W5RES	15
Dennis J. Niles, WV7S	15
Gregory L. Rix, WB7GR	15
Stanford H. Rowe, K6VWE	15
Otto P. Altobelli, K2BY	20
Thomas H. Beebe, W9RY	20
Robert S. Boles, WB4SED	20
Lynn R. Landin, WBØU	20
Dennis M. Markell, N1IMW	20
David J. O'Farrell, WBØIXV	20
Harold E. Fox, K7SAX	30
Gilbert D. Woodside, III, WA1LAD	35
Richard T. Boswell, II, K4CUE	40

January 2020

John M. Dziedziejko, W9QP	10
Marlo Montanaro, KA2IRQ	10
Warren D. Zimmer, KC7ND	10
Scott J. Bertrand, AI4TT	15
Ishan Kumaraswami, AC2MX	15
James D. Russ, AB4KA	15
David W. Rice, AD8WR	20
Carl W. Davis, W8WZ	25

Congratulations to all the recipients.

March 2020 W1AW Qualifying Runs

W1AW, the Hiram Percy Maxim Memorial Station at ARRL Headquarters in Newington, Connecticut, transmits Morse code Qualifying Runs to assist ham radio operators in increasing and perfecting their proficiency in Morse code. Amateur radio operators can earn a Certificate of Code Proficiency or endorsements by listening to W1AW Qualifying Runs.

March Qualifying Runs will be transmitted by W1AW in Newington, Connecticut at the times shown at 1.802.5, 3.581.5, 7.047.5, 14.047.5, 18.097.5, 21.067.5, 28.067.5, 50.350, and 147.555 MHz. The West Coast Qualifying Runs will be transmitted by K6KPH on Saturday, March 21 at 2 PM PDT (2100 UTC) on 3581.5, 7047.5, 14047.5, and 18097.5 kHz. Unless indicated otherwise, sending speeds are from 10 to 35 WPM.

Amateur radio operators who participate in Qualifying Runs may submit proof of 1 minute of the highest speed they have copied in the hope of qualifying for the Certificate of Code Proficiency, or an endorsement to their existing Certificate.

Legibly copy at least 1 minute of text by hand, and mail the sheet to: W1AW Qualifying Runs, 225 Main St., Newington, CT USA 06111.

Include $10 (check or money order) if this is a submission for your initial Code Proficiency certificate; $7.50 if you are applying for an endorsement (available for speeds up to 40 WPM). Your test will be checked against the actual transmissions to determine if you have qualified.

For more information about Qualifying Runs, please visit **www.arrl.org/qualifying-run-schedule**.

For information about how to qualify for the Certificate of Code Proficiency, please visit **www.arrl.org/code-proficiency-certificate.**

W1AW Code Proficiency Schedule — March 2020
(All times in Eastern Daylight Time, unless otherwise noted.)

Monday	Tuesday	Wednesday	Thursday	Friday
3/2 4 PM – 2100Z EST 10 – 35 WPM	**3/3** 7 PM – 0000Z EST **(3/4 – UTC)** 35 – 10 WPM		**3/5** 10 PM – 0300Z EST **(3/6 – UTC)** 10 – 40 WPM	**3/6** 9 AM – 1400Z EST 10 – 35 WPM
	3/10 4 PM – 2000Z 10 – 35 WPM	**3/11** 7 PM – 2300Z 10 – 40 WPM	**3/12** 9 AM – 1300Z 35 – 10 WPM	**3/13** 10 PM – 0200Z **(3/14 – UTC)** 10 – 35 WPM
	3/17 9 AM – 1300Z 10 – 35 WPM	**3/18** 10 PM – 0200Z **(3/19 – UTC)** 35 – 10 WPM	**3/19** 7 PM – 2300Z 10 – 35 WPM	**3/20** 4 PM – 2000Z 10 – 40 WPM
3/23 10 PM – 0200Z **(3/24 – UTC)** 10 – 40 WPM		**3/25** 9 AM – 1300Z 35 – 10 WPM	**3/26** 4 PM – 2000Z 35 – 10 WPM	**3/27** 7 PM – 2300Z 10 – 35 WPM

Convention and Hamfest Calendar

Abbreviations

Spr = Sponsor
Tl = Talk-in frequency
Adm = Admission

Alabama (Fort Payne) — Mar. 28 D F H R T V
8 AM – noon. *Spr:* Dekalb County ARC. Dekalb County VFW Fairgrounds, 151 18th St NE. *Tl:* 147.27 (100 Hz). *Adm:* $5. **www.w4gbr.org**

Arizona (Scottsdale) — Mar. 21 D F H R S T V
6 AM – noon. *Spr:* ARCA and Scottsdale ARC. Mountain Valley Community Church, 17700 N. Perimeter Dr. *Tl:* 147.18 (162.2 Hz). *Adm:* $5. **www.scottsdalearc.org**

Arkansas (Fort Smith) — Apr. 4 D F H Q R V
8 AM. *Spr:* Fort Smith Area ARC. Sebastian County Emergency Storm Shelter, Ben Geren Park, 7070 S. Zero St. *Tl:* 146.64 (88.5 Hz). *Adm:* $5. **www.fsaarc.org**

California (Loomis) — Mar. 21 D F H Q R S T
7 AM – noon. *Spr:* Sierra Foothills ARC. Historic Loomis Train Depot Plaza, 5775 Horseshoe Bar Rd. *Tl:* 145.43 (162.2 Hz). *Adm:* Free. **www.w6ek.org**

Colorado (Longmont) — Apr. 4 D F H R S V
8 AM – 2 PM. *Spr:* Longmont ARC. Boulder County Fairgrounds Exhibit Building, 9595 Nelson Rd. *Tl:* 147.27 (100 Hz). *Adm:* $5, age 16 and younger free admission. **www.w0eno.org**

Connecticut (Southington) — Mar. 29 D F H R S V
8 AM – noon. *Spr:* Southington ARA. Southington High School, 720 Pleasant St. *Tl:* 147.345, –444.2 (–151.4 Hz). *Adm:* $5. **www.chetbacon.com/sara.htm**

Florida (Coral Gables) — Mar. 14 F T
7 AM – noon. *Spr:* Flamingo Net ARC. University of Miami (UM) Parking Lot 1-109, 1300 Campo Sano Ave. *Tl:* 147.15 +600 (94.8 Hz). *Adm:* Free admission, UM parking fee $1.50/hr. **www.flamingonet.8m.net**

Florida (Fort Walton Beach) — Mar. 20 – 21 D F H Q S V
Friday 4 – 8 PM, Saturday 8 AM – 2 PM. *Spr:* Playground ARC. C.H. "Bull" Rigdon Fairgrounds, 1958 Lewis Turner Blvd. *Tl:* 146.79 (100 Hz). *Adm:* $7. **www.w4zbb.org**

Florida (New Port Richey) — Mar. 14 F T V
8 AM – noon. *Spr:* Gulf Coast ARC. Millennium Academy, 10005 Ridge Rd. *Tl:* 146.67 (146.2 Hz). *Adm:* $5. **www.gulfcoastarc.org**

Florida (Sarasota) — Mar. 28 D F H R S T
7 AM – noon. *Spr:* Sarasota Emergency RC. American Red Cross Campus, 2001 Cantu Ct. *Tl:* 146.73 (100 Hz). *Adm:* $2. **www.n4ser.org**

Florida (Stuart) — Mar. 21 D F H R S T V
8 AM – 3 PM. *Spr:* Martin County ARA. Martin County Fairgrounds, 2616 SE Dixie Hwy. *Tl:* 147.06. *Adm:* Free.

Indiana (Brazil) — Mar. 15 D F H R
8 AM – noon. *Spr:* Wabash Valley ARA. Clay County Fairgrounds, 6550 N. State Rd. 59. *Tl:* 146.685 (151.4 Hz). *Adm:* $7. **www.w9uuu.org**

Iowa (Oskaloosa) — Mar. 21 D F H R
8 – 11:30 AM. *Spr:* Mahaska ARC. American Legion Hall, 302 High Ave. E. *Tl:* 145.49 – 600 (146.2 Hz). *Adm:* Donations accepted.

LOUISIANA STATE CONVENTION

March 13 – 14, Rayne, LA
D F H R S T V
Friday 3 – 8 PM, Saturday 8 AM – 3 PM. *Spr:* Acadiana ARA. Rayne Civic Center, 210 Frog Festival Dr. *Tl:* 146.82 – 600 (103.5 Hz) *Adm:* Advance $5, door $8. **www.w5ddl.org/hamfest.htm**

Minnesota (Buffalo) — Mar. 21 H Q R V
8 AM – 1 PM. *Spr:* Maple Grove RC. Buffalo Civic Center, 1306 County Rd. 134 NE. *Tl:* 147.0 (114.8 Hz). *Adm:* $10. **www.k0ltc.org**

Missouri (Boonville) — Mar. 21 D F H R
8 AM – 3 PM. *Spr:* Boonville ARC. Cooper County Youth Fairgrounds, 16899 Dunkles Dr. *Tl:* 147.36 (127.3 Hz). *Adm:* $3. **www.w0brc.org**

OZARKCON QRP CONFERENCE

April 3 – 4, Branson, MO
H R S
Friday noon – 8 PM, Saturday 9 AM – 5 PM. *Spr:* Four State QRP Group. Stone Castle Hotel and Conference Center, 3050 Green Mountain Dr. *Adm:* Advance $12, door $15. **www.ozarkcon.com**

Missouri (Mt. Vernon) — Mar. 28 D F H R S V
8 AM – 1 PM. *Spr:* Ozarks ARS. Mt. Vernon Arts and Recreation Center, 822 W. Mt. Vernon Blvd. *Tl:* 146.97 (162.5 Hz). *Adm:* Advanced $5, door $8. **www.w0oar.com/annual-oars-hamfest/**

Nebraska (Lincoln) — Mar. 14 D F H R S V
8 AM – 3 PM. *Spr:* Lincoln ARC. Lancaster Event Center, 4100 N. 84th St. *Tl:* 146.76. *Adm:* $8, LARC members $5. **www.lincolnhamfest.org**

New Hampshire (Hampton) — Apr. 4 D F H R T V
8 AM – noon. *Spr:* Port City ARC. St. James Masonic Lodge, 77 Tide Mill Rd. *Tl:* 145.15 (127.3 Hz). *Adm:* $5. **www.w1wqm.org**

New Hampshire (Henniker) — Mar. 22 D F H R S V
8 AM – 2 PM. *Spr:* Contoocook Valley RC. Henniker Community School, 51 Western Ave. *Tl:* 146.895 (100 Hz). *Adm:* $3. **www.k1bke.org**

New Jersey (Clinton) — Mar. 14 D F H R S V
8 AM. *Spr:* Cherryville Repeater Association. N. Hunterdon Regional High School, 1445 Rt. 31. *Tl:* 147.375 +.6 (151.4 Hz). *Adm:* $5. **www.qsl.net/w2cra**

New Jersey (Parsippany) — Mar. 28 D F H R
8 AM – noon. *Spr:* New Jersey Antique RC. Parsippany PAL Building, 33 Baldwin Rd. *Tl:* No talk-in frequency. *Adm:* $5.

New York (Norwich) — Apr. 4 D F H R T V
7 AM – noon. *Spr:* Chenango Valley ARA. Chenango County Pomona Grange, 167 County Rd. 32A. *Tl:* 146.685 (110.9 Hz). *Adm:* $5. **www.cvara.net/events**

A = AUCTION
D = DEALERS / VENDORS
F = FLEA MARKET
H = HANDICAP ACCESS
Q = FIELD CHECKING OF QSL CARDS
R = REFRESHMENTS
S = SEMINARS / PRESENTATIONS
T = TAILGATING
V = VE SESSIONS

NORTH CAROLINA SECTION CONVENTION

March 13 – 14, Concord, NC

D F H Q R S V

Friday 3 – 7 PM, Saturday 8:30 AM – 3 PM. *Spr:* Mecklenburg ARS. Cabarrus Arena & Events Center, 4551 Old Airport Rd. *Tl:* 146.655 –600. *Adm:* Advance $9, door $10. **www.charlottehamfest.org**

Ohio (Gallipolis) — Mar. 21 D F H R T V

8 AM – noon. *Spr:* Mid-Ohio Valley ARC. Gallia County Senior Citizens Center, 1165 State Rte. 160. *Tl:* 147.06 (74.4 Hz). *Adm:* $5. **http://sites.google.com/site/midohiovalleyarc**

GREAT LAKES DIVISION CONVENTION

March 14 – 15, Perrysburg, OH

D F H R V

8 AM. *Spr:* Toledo Mobile Radio Assn. Owens Community College, 30335 Oregon Rd. TMRA Hamfest & Computer Fair. *Tl:* 147.27 (103.5 Hz). *Adm:* $8. **www.tmrahamradio.org**

Pennsylvania (Mckeesport) — Mar. 29 D F H Q R S V

8 AM – 2 PM. *Spr:* Two Rivers ARC. Mckeesport Palisades, 100 5th Ave. *Tl:* 146.73. *Adm:* Advanced $5, door $7.

Pennsylvania (Youngsville) — Mar. 14 D F H Q R V

7 AM – 1 PM. *Spr:* BSA Venturing Crew 73. Youngsville Volunteer Fire Dept., 222 E. Main St. *Tl:* 147.015 (186.2 Hz). *Adm:* $5.

Tennessee (Sevierville) — Mar. 28 D F H Q R S T V

8 AM – 4 PM. *Spr:* Sevier County ARS. Sevier County Fairgrounds, 754 Old Knoxville Hwy. *Tl:* 146.94. *Adm:* $5. **www.seviercountyars.org**

Tennessee (Tullahoma) — Mar. 14 D F H R S T V

8 AM – 2 PM. *Spr:* Middle TN ARS. First United Methodist Church, 208 W. Lauderdale St. *Tl:* 146.7 –600 (114.8 Hz). *Adm:* $5. **www.qsl.net/mtars**

Tennessee (Union City) — Mar. 28 D F H Q R S T V

8 AM – 1 PM. *Spr:* Reelfoot ARC. National Guard Armory, 2017 E. Reelfoot Ave. *Tl:* 146.8 (100 Hz). *Adm:* $8. **www.reelfootarc.com**

VERMONT STATE CONVENTION

February 22, Colchester, VT

D F H Q S V

8 AM – 2 PM. *Spr:* Radio Amateurs of Northern Vermont. Hampton Inn, 42 Lower Mountain Rd. *Tl:* 145.15 (100 Hz). HAM-CON. *Adm:* Advance $6, door $9. **www.ranv.org/hamcon.html**

WEST TEXAS SECTION CONVENTION

March 21, Midland, TX

D F H Q R S V

8 AM – 4 PM. *Spr:* Midland ARC. MLK Community Center, 2300 Butternut Ln. St. Patrick's Day Hamfest. *Tl:* 147.3 (88.5 Hz). *Adm:* Free. **www.hamfest.w5qgg.org**

WEST VIRGINIA SECTION CONVENTION

March 12, Charleston, WV

D F H Q R S V

9 AM – 2 PM. *Spr:* Charleston Hamfest Committee. Charleston Coliseum & Convention Center, 200 Civic Center Dr. Charleston Hamfest. *Tl:* 145.35 (91.5 Hz). *Adm:* $8. **www.chaswvhamfest.com**

Wisconsin (Jefferson) — Mar. 15 D F H Q R V

8 AM – noon. *Spr:* Jefferson County ARES. Jefferson County Fairgrounds Activity Center, 503 N. Jackson Ave. *Tl:* 145.49 (123 Hz). *Adm:* $7. **www.w9mqb.com**

Wisconsin (Milwaukee) — Apr. 4 F H R

8 AM – noon. *Sprs:* Milwaukee RAC, Milwaukee Area ARS. Elks Lodge #46, 5555 W. Good Hope Rd. *Tl:* 145.13, 145.39 (127.3 Hz). *Adm:* Advance $4, door $5. **www.w9rh.org/club-events/swapfest**.

To All Event Sponsors

Before making a final decision on a date for your event, you are encouraged to check the Hamfest and Convention Database (**www.arrl.org/hamfests-and-conventions-calendar**) for events that may already be scheduled in your area on that date. You are also encouraged to register your event with HQ as far in advance as your planning permits. See **www.arrl.org/hamfest-convention-application** for an online registration form. Dates may be recorded up to 2 years in advance.

The deadline for receipt of items for this column is the **1st of the second month preceding publication date**. For example, your information must arrive at HQ by **April 1** to be listed in the **June** issue. Information in this column is accurate as of our deadline; contact the sponsor or check the sponsor's website for possible late changes, driving directions, and other event details. Please note that postal regulations prohibit mention in *QST* of games of chance, such as raffles or bingo.

New Books

Global Radio Guide, 13th Edition

Teak Publishing has announced the release of the 13th edition of the *Global Radio Guide* (Winter 2019 – 2020 edition) by Gayle Van Horn, W4GVH.

At the heart of this electronic publication is a 24-hour station/frequency guide with all the latest winter 2019 – 2020 schedules for selected AM broadcast, longwave, and shortwave radio stations. There are listings of DX radio programs and internet website addresses for many of the stations. There are also entries for time and frequency stations and other intriguing shortwave radio stations.

The *Global Radio Guide* is available for $8.99 on **Amazon.com** as an e-book that can be viewed on any smartphone, tablet, or computer using free software (regardless of the operating system), or on any Amazon Kindle reader.

Feedback

■ In the article "An SWR-Shifting **T**" by Bill Conwell, K2PO, published in the February issue of *QST*, it should be noted that depending on the transmit power and capacitance value needed, there can be high circulating currents in the capacitor. The CDE catalog lists mica capacitor series and their continuous current versus capacitance value and frequency. Lower current capacitors can also be paralleled to increase the current rating.

W1AW Schedule

PAC	MTN	CENT	EAST	UTC	MON	TUE	WED	THU	FRI
6 AM	7 AM	8 AM	9 AM	1300		FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
7 AM-1 PM	8 AM-2 PM	9 AM-3 PM	10 AM-4 PM	1400-1600 1700-1945	VISITING OPERATOR TIME (12 PM-1 PM CLOSED FOR LUNCH)				
1 PM	2 PM	3 PM	4 PM	2000	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
2 PM	3 PM	4 PM	5 PM	2100	CODE BULLETIN				
3 PM	4 PM	5 PM	6 PM	2200	DIGITAL BULLETIN				
4 PM	5 PM	6 PM	7 PM	2300	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE
5 PM	6 PM	7 PM	8 PM	0000	CODE BULLETIN				
6 PM	7 PM	8 PM	9 PM	0100	DIGITAL BULLETIN				
6:45 PM	7:45 PM	8:45 PM	9:45 PM	0145	VOICE BULLETIN				
7 PM	8 PM	9 PM	10 PM	0200	FAST CODE	SLOW CODE	FAST CODE	SLOW CODE	FAST CODE
8 PM	9 PM	10 PM	11 PM	0300	CODE BULLETIN				

W1AW's schedule is at the same local time throughout the year. From the second Sunday in March to the first Sunday in November, UTC = Eastern US time + 4 hours. For the rest of the year, UTC = Eastern US time + 5 hours.

♦ Morse code transmissions: Frequencies are 1.8025, 3.5815, 7.0475, 14.0475, 18.0975, 21.0675, 28.0675, 50.350, and 147.555 MHz.

Slow Code = practice sent at 5, 7½, 10, 13, and 15 WPM.

Fast Code = practice sent at 35, 30, 25, 20, 15, 13, and 10 WPM.

Code bulletins are sent at 18 WPM.

For more information, visit us at
www.arrl.org/w1aw

♦ W1AW Qualifying Runs are sent on the same frequencies as the Morse code transmissions. West Coast qualifying runs are transmitted by various West Coast stations on CW frequencies that are normally used by W1AW, in addition to 3590 kHz, at various times. Underline 1 minute of the highest speed you copied, certify that your copy was made without aid, and send it to ARRL for grading. Please include your name, call sign (if any), and complete mailing address. Fees: $10 for a certificate, $7.50 for endorsements.

♦ Digital transmissions: Frequencies are 3.5975, 7.095, 14.095, 18.1025, 21.095, 28.095, 50.350, and 147.555 MHz.

Bulletins are sent using 45.45-baud Baudot, PSK31 in BPSK mode, and MFSK16 on a daily revolving schedule.

Keplerian elements for many amateur satellites will be sent on the regular digital frequencies on Tuesdays and Fridays at 6:30 PM Eastern time using Baudot and PSK31.

♦ Voice transmissions: Frequencies are 1.855, 3.99, 7.29, 14.29, 18.16, 21.39, 28.59, 50.350, and 147.555 MHz. Voice transmissions on 7.290 MHz are in AM double sideband, full carrier.

♦ Notes: On Fridays, UTC, a DX bulletin replaces the regular bulletins. W1AW is open to visitors 10 AM to noon and 1 PM to 3:45 PM Monday through Friday. FCC-licensed amateurs may operate the station during that time. Be sure to bring your current FCC amateur license or a photocopy. In a communication emergency, monitor W1AW for special bulletins as follows: voice on the hour, teleprinter at 15 minutes past the hour, and CW on the half hour.

W1AW code practice and CW/digital/phone bulletin transmission audio is also available real-time via the *EchoLink Conference Server* W1AWBDCT. The conference server runs concurrently with the regularly scheduled station transmissions. The W1AW Qualifying Run texts can also be copied via the EchoLink Conference Server.

During 2020, Headquarters and W1AW are closed on New Year's Day, Presidents Day (February 17), Memorial Day (May 25), Independence Day (July 4), Labor Day (September 7), Veterans Day (November 11), Thanksgiving and the following day (November 26 and 27), and Christmas (December 25).

ARRL VEC Volunteer Examiner Honor Roll

The ARRL VEC Honor Roll recognizes the top five Volunteer Examiners in each ARRL Division according to the total number of ARRL exam sessions in which they have participated since their accreditations. Considering each session requires an average time commitment of 2 to 4 hours or more, the thousands of hours these VEs have invested represent extraordinary dedication! Whether you are one of our VE Teams that tests once a week, once a month, or once a year, we want to express our warmest appreciation to all volunteers for your generous contribution to the ARRL VEC program.

If you are an ARRL VE, you can view your session stats online at **www.arrl.org/ve-session-counts**.
If you are not a VE, become one today! See **www.arrl.org/become-an-arrl-ve**.

Examiner	*Sessions*	*Accreditation Date*
Atlanta		
Jobst Vandrey, AC0LP	323	23-Jun-08
James McCloskey, NS3K	318	14-Nov-94
Edward Genoino, WA2NDA	298	10-Jul-85
George Brechmann, N3HBT	278	01-Apr-91
Robert Benna, N3LWP	230	21-May-97
Central		
Ed Wagner, AB9FN	333	01-Jul-02
Eldon Boehm, NK9U	313	21-Nov-86
Allan Bukowski, N9ZD	310	01-Jun-92
Donald Hlinsky, N9IZU	299	01-Mar-91
Timothy Pechtold, AA9BV	274	01-Nov-92
Dakota		
John Schwarz, Jr., AE0AL	307	26-Oct-94
Jeffrey Goodnuff, W0KF	301	17-Jun-03
Shep Shepardson, N0NMZ	245	12-Mar-01
Daniel Royer, KE0OR	235	01-Jul-91
Dennis Ackerman, KB0OQQ	220	15-Jul-96
Delta		
Arthur Parry, Jr., WB4BGX	267	01-May-91
Glenn King, N5GK	244	05-Jun-86
Joe Lowenthal, WA4OVO	234	25-May-06
Roger Gray, N5QS	226	01-Mar-93
Bobbie Williams, W1BEW	211	01-Jun-92
Great Lakes		
Charles Hall, W8HF	282	01-Jun-92
Dale Pritchett, KC8HJL	223	26-Mar-98
Archie Mack, Sr., AF4EB	222	19-Aug-97
Christian Anderson, K8VJ	219	09-Feb-90
James Viele, W8JV	210	22-Mar-90
Stanley Arnett, II, AC8W	210	06-Sep-84

Examiner	*Sessions*	*Accreditation Date*
Hudson		
Paul Maytan, AC2T	651	06-Sep-84
Stanley Rothman, WA2NRV	450	01-Mar-85
E. Drew Moore, W2OU	437	01-Aug-90
Fritz Boigris, KB2O	410	26-Oct-84
Gerald Miller, Jr., AA2ZJ	399	05-Dec-95
Midwest		
David Bartholomew, AB0TO	716	22-Mar-02
Kevin Naumann, N0WDG	629	17-Nov-02
Harry Steger, Jr., W0HMS	551	26-Aug-08
Roland Kramer, W0RL	521	21-Jun-01
Jeanette Nordman, AB0YX	460	21-Aug-03
New England		
Robert Beaudet, W1YRC	380	01-Aug-90
Paul Lux, K1PL	342	25-Jan-85
Bruce Anderson, W1LUS	338	11-Feb-88
Lawrence Polowy, KU1L	337	02-Jan-85
James Mullen, KK1W	332	01-Mar-91
Stefan Rodowicz, N1SR	332	20-Nov-84
Northwestern		
Richard Morgan, KD7GIE	450	11-Aug-00
Loren Hole, KK7M	380	06-Sep-84
George Ftikas, N7TQZ	299	01-Dec-92
David Brooks, N7HT	292	10-Jun-87
S. Riley McLean, W7RIL	288	02-Sep-99
Pacific		
Morris Jones, AD6ZH	474	27-Nov-01
Dieter Stussy, KD6LVW	411	27-Jan-94
Gordon Fuller, WB6OVH	348	06-Sep-84
Bill Nichols, NN7K	326	01-Sep-93
Jim Brunk, N6BHX	280	13-Jul-95

Examiner	*Sessions*	*Accreditation Date*
Roanoke		
Judy Friel, AC4RG	282	01-Feb-91
Alan Ronald Moeck, WA2RPX	263	27-Sep-94
David Snyder, W4SAR	246	01-May-93
Sheila Frank, KT4YW	221	30-Oct-96
Terry Sanner, WV8V	213	06-Sep-84
Rocky Mountain		
Robert Hamilton, N0RN	377	19-May-87
David Avery, N0HEQ	298	13-Jan-88
Jeffrey Weinberg, W0QO	287	01-Apr-93
Philip O'Kunewick, AB0JR	274	24-Feb-00
David Sharpe, KI0HG	254	02-Feb-98
Southeastern		
Victor Madera, KP4PQ	462	01-Mar-92
Val Jacyno, AK4MM	385	08-Nov-11
Pablo Soto, KP4SJ	370	01-May-92
Robert Cumming, Sr., W2BZY	351	29-Jan-97
Joseph Patti, N4UMB	319	01-Sep-90
Southwestern		
Bill Martin, AI0D	1,025	01-Nov-84
Fred Bollinger, AB7JF	531	17-Apr-95
David Morrill, N7TWT	422	20-Jul-00
Steve Gurley, KY7W	409	19-Apr-96
Joseph Cutitta, W0SLL	406	09-Nov-99
West Gulf		
Franz Laugermann, K3FL	1,039	01-Dec-91
Wilbert Cannonier, KK5JJ	465	03-Nov-95
Adolph Chris Koehler, K5VCR	460	29-Sep-95
Gerald Grant, WB5R	460	04-Jan-85
David Fanelli, KB5PGY	435	01-Oct-91

Write for *QST*

The membership journal of ARRL is always open to manuscript submissions from ham radio operators.

QST looks for material that appeals to a broad cross-section of readers within the diverse Amateur Radio community. Feature articles published in *QST* fall into one of two broad categories: *technical* and *general interest*.

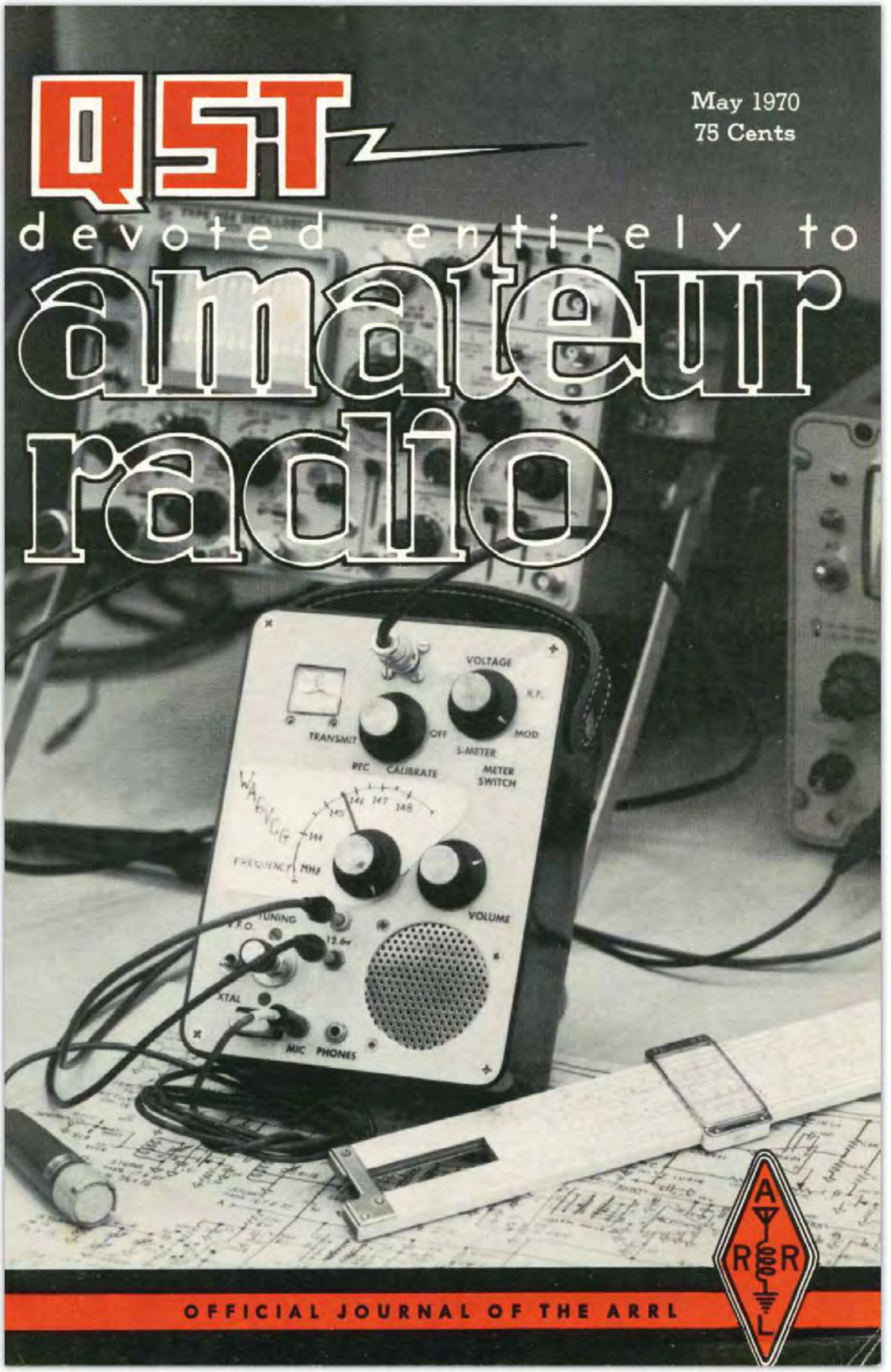
Technical articles outline a construction project or a technical concept. General interest articles are "everything else" that's not technical: recaps of DXpeditions, grid expeditions, or public service activities; personal accounts of trying a new mode or style of operating — anything relating to operating or the ham radio avocation.

Whether your manuscript has a technical or general focus, a strong "how-to" component will make it stand out. Readers should come away from the article with specific ideas for recreating your experience.

Please note that *QST* only considers complete manuscripts — we do not evaluate concepts or ideas for manuscripts. The best way to find out whether the editors of *QST* are interested in your idea is to write the article and send it in for consideration via postal mail or email (no phone calls, please).

For more information on what *QST* is looking for, and how to submit manuscripts, see our Author Guide at **www.arrl.org/qst-author-guide**.

A Look Back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● *Beginner and Novice*

A Solid-State Selectoroid

Audio Selectivity With a Simple Device

BY LEWIS G. McCOY,* W1ICP

ONE OF the more serious problems the Novice has to contend with is QRM. The Novice bands, particularly 80 and 40 meters, can become very congested at times, and trying to copy a desired station can sometimes be very difficult. To make the problem even worse, many Novices start out in amateur radio using low-priced receivers that are lacking in selectivity. While it is possible to rework a receiver to improve the selectivity, most Novices are reluctant to dig into a receiver to make changes. This is understandable because it does take a certain amount of know-how and experience to modify equipment.

On the other hand, it can be very difficult to separate stations in a congested band if the receiver has poor selectivity. Many newcomers have the the mistaken notion that the answer is to have more bandspread on their receivers. However, this is rarely the case.

Basically, bandspread is the ability of a receiver to cover a given frequency range by "spreading" the band out on the tuning dial. However, it doesn't mean that two stations that are operating close together are more separated. It just means that you can tune across the two stations at a slower rate. The ability of a receiver to separate stations that are close together is called *selectivity*, or the ability to select the *desired* signal, and discriminate against others.

There are many methods by which the selectivity of a receiver can be improved. One of the simplest, because it doesn't necessarily require any internal modifications to the receiver, is called audio selectivity. The Selectoroid, described in this article, is a device that will provide such selectivity. It is easy to build and get working, and can prove a real boon under QRM conditions.

*Novice Editor

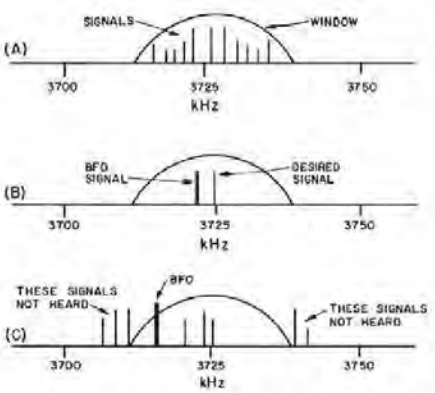


Fig. 1 — This drawing illustrates the discussion in the text.

The Selectoroid is housed in a homemade aluminum box. Two aluminum U-shaped channels are used for the case.

How It Works

Let's take a moment to visualize how a receiver works as far as selectivity is concerned. Also, let's suppose we are going to tune the Novice portion of the 80-meter band, 3700 to 3750 kHz. Just for an illustration, let's assume our tuning dial is a window that we can move up and down the band as we operate the tuning dial. Our window has a certain width, and this width can be called the *bandwidth* of the receiver. Any signals that appear in the window, can be heard. Fig. 1, at A, is an illustration of this window and represents the Novice portion of the band.

In order to hear cw signals, we need a beat-frequency oscillator signal in our window. As we move our window, the BFO signal moves right along with the window. Now, let's suppose there is a signal at 3725 kHz, as in Fig. 1 at B. As our BFO signal approaches the other signal, the two signals beat against one other, resulting in a signal that is the audio difference between the two. If our BFO is 3000 Hz away from the desired signal, we would

In December 1966 *QST* we described a tube version of a selective audio filter. The unit was called a Selectoroid. Here is a transistorized version of the same unit.

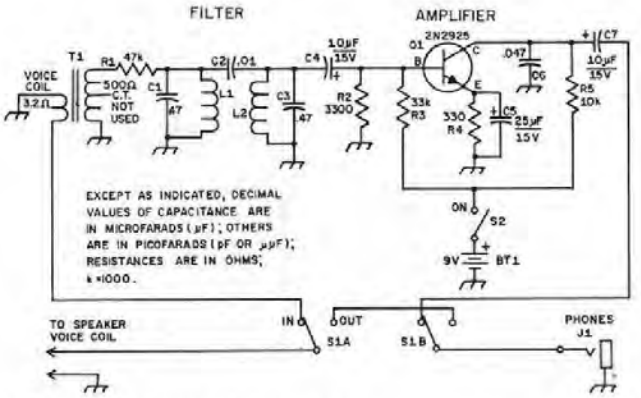


Fig. 2 — Circuit diagram of the solid-state Selectoroid. Capacitances are in uF, resistances are in ohms, and all resistors are ½ watt. Circuit designations not given below are for parts placement reference.

BT1 — 9-volt battery.
C1,C3 — 0.47-uF paper.
C2 — 0.01-uF disk ceramic.
C4,C7 — 10-uF electrolytic, 15 working volts or higher.
C5 — 25-uF electrolytic, 15 working volts or higher.
J1 — Headphone jack.
L1,L2 — 88-mH toroid. See text.
Q1 — 2N2925.
S1 — 2pdt toggle (See text).
S2 — Spst toggle.
T1 — Transistor output transformer, 3-ohm voice coil, 500-ohm primary, primary center tap not used, (Lafayette Radio catalog No. 99 H 6123).

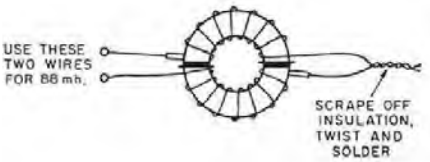
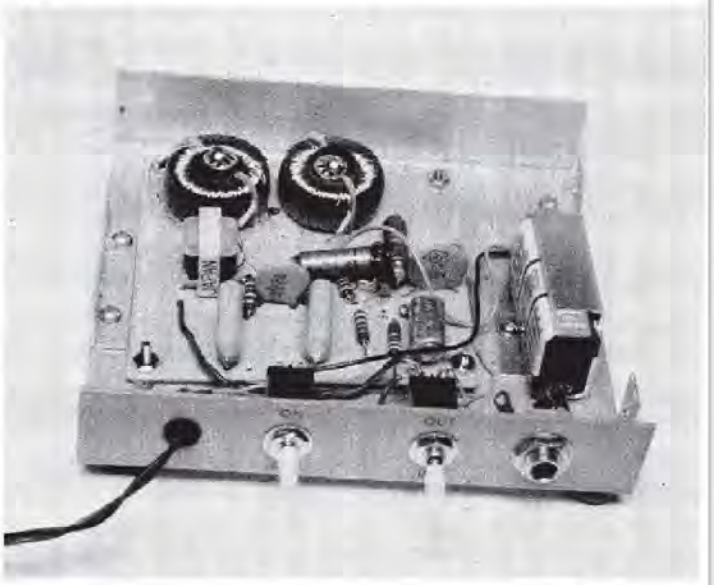


Fig. 3 — This drawing shows the method for connecting the toroid windings to obtain the required 88-mH inductance.



Inside view of the audio filter. Most of the parts are mounted on an etched-circuit board (left). L brackets are shown on the left and right edges of the bottom cover. These are used as anchor points for the top cover when it is attached. Sheet-metal screws hold the top cover to the brackets.

hear a 3000-Hz tone in our headphones. As the BFO signal is moved closer to the desired signal, the difference decreases, and the resulting tone gets lower and lower in pitch. When the two signals are on the same frequency, they are said to be *zero beat* and there will be no tone in our headphones.

As we continue to tune the BFO signal in the same direction, past the other signal, the difference between the two increases and the audio note also rises in pitch. The side of the signal we *are not* listening to is called the *audio image signal.*

Let's assume that our window is 16,000 Hz wide (16 kHz). If our desired signal was at the edge of the window, and our BFO at the exact center, we would start hearing an 8000-Hz tone, gradually decreasing in pitch until we reached zero beat, and then increasing as the window was moved past the desired signal.

From the example just given, it should be apparent that if we had two signals in the window, at opposite sides of the BFO, we would hear both signals because the BFO would beat against both. In the ideal setup, the BFO signal should be set near the edge of the window, as in Fig. 1 at C. Under these conditions, the BFO can *only* beat against signals that are to one side of the BFO and inside the window. This type of selectivity is called single-signal selectivity, because the audio image of the signal is not heard. Also, it follows that the narrower the window, the more the undesired signals will be rejected.

If the Novice is shopping for a new receiver, he'll find that most of the better receivers have built-in filters that usually provide a "window" of about 2100 Hz (2.1 kHz). The reason that this figure is chosen is because 2100 Hz is about as narrow as one can get and still provide good intelligibility of phone signals. With the BFO set on the edge of such a passband, *only* signals within the passband will be heard. In some receivers, the purchaser may have the option of buying an additional filter for cw. These are usually on the order of 500 Hz, and some are as sharp as 200 Hz.

Naturally, the question many newcomers would ask is, "Can I install such a filter in my present receiver?" The answer is yes, but as pointed out earlier, it isn't an easy task for a newcomer who doesn't have the know-how. This leads us up to the Selectoroid – a method for improving the selectivity in the audio channel, or at the output end of the receiver.

Fig. 2 is the circuit diagram of the Selectoroid. The important parts of the unit are the two tuned circuits, C1L1, and C3L2. These are sharply-resonant circuits tuned to approximately 800 Hz. When our window and BFO are tuned across a

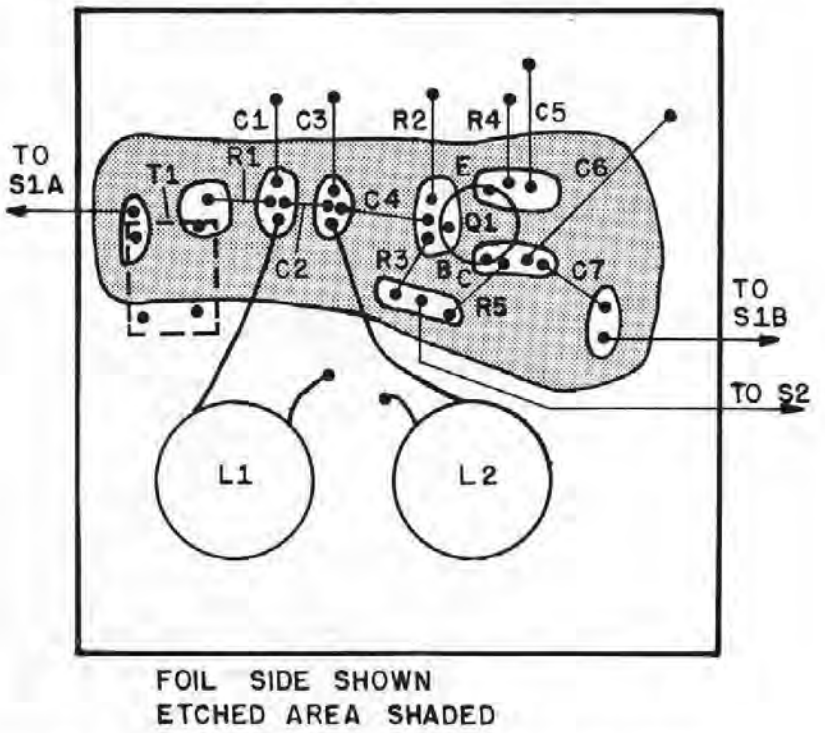


Fig. 4 – Layout of the etched-circuit board. The etched, or foil side is shown. (Ready-made circuit boards can be purchased from Stafford Electronics, 427 S. Benbow Rd., Greensboro, N.C. 24701.)

signal, all the audio range of the signal will be attenuated with the exception of a very narrow portion of the signal around 800 Hz. The listening effect is that when the receiver is tuned to 800 Hz, the cw note will peak quite sharply. Or in other words, the filter will "select" that portion of the signal around 800 Hz and attenuate everything else. No modifications of the receiver are required, and the only connections needed are to the speaker terminals on the receiver.

Because there is some audio loss through the Selectoroid, an audio amplifier stage, Q1, was added to the unit. The unit is powered by a 9-volt battery. The drain on the battery is only a couple of milliamperes, so BT1 should last almost as long as its normal shelf life. S1 is a double-pole, double-throw toggle switch that is used to switch the Selectoroid in or out.

Construction Information

The inductors used for L1 and L2 are types made for teletype units and you'll find them advertised in *QST* Ham Ads every month. The prices vary, but the toroids can usually be obtained for about 50 cents each. As they come, the toroids have two windings on them. These windings must be connected in series in order to obtain the required 88-mH inductance. Fig. 3 is a sketch that shows how the windings should be connected. Be sure to scrape the enamel covering from the wires before soldering them together.

In the unit shown, an etched-circuit board is used for mounting the components. Fig. 4 shows the etched side of the board with the various components marked off as lines to show their placement on the board. All the components are mounted on the unetched side of the board. A recent article in *QST*[1] covered the construction of etched-circuit boards in considerable detail, so the subject won't be treated here. Layout of the circuit is not at all critical, and any arrangement of the parts will work.

When mounting the transistor on the etched-circuit board, be sure to use a heat sink on the leads being soldered. This will prevent damage to the transistor. We mounted the completed board in a homemade low-profile cabinet, as shown in the photograph. The dimensions for the box, made from cookie-sheet aluminum, are 5 x 5 inches, with a 1-inch high lip on the front and back. The toggle switches used are of the miniature type, and if the normal-size toggles are used, the back and front lip of the box should be 1 1/2 inches high. You don't have to build the unit exactly as shown, as any size box that will hold the parts will work. However, we like the low-profile enclosure because it takes up less desk space than a larger cabinet would.

In order to keep the bottom side of the etched board from shorting to the metal chassis, a piece of stiff cardboard is mounted between the metal chassis and the bottom of the board. Make sure, however, that there is a good connection from the metal chassis ground to the copper-foil ground on the etched-circuit board.

[1]Schiebold, "Fast'n' Easy Printed Circuits," *QST*, August, 1969.

Using The Selectoroid

After the unit is completed it should be hooked up to the station receiver. The two leads from the Selectoroid can be connected to the voice coil terminals on the receiver, or at the speaker. The input of the Selectoroid is designed for 3- to 8-ohm impedance, which should be in the range of your speaker's impedance. The leads from the Selectoroid can be connected directly in parallel with the speaker leads if desired. However, some users might like to have the speaker shut off while listening with the headphones. All that is necessary in such a case is a single-pole switch to open one of the speaker leads when the Selectoroid is in use. Be sure you connect the Selectoroid leads on the *receiver* side of the switch, otherwise you'll be shutting off the input to both the speaker and the Selectoroid.

All you need do to use the Selectoroid is tune in a cw signal. As you tune across the signal you'll hear a sharp peak around the 800-Hz region. Switching the Selectoroid in and out of the receiver output will quickly show you just how much the unit eliminates QRM. As was said earlier, this is an easy and cheap method for improving your receiver's performance. QST

Strays

Ham Radio at AFCEA – 1970

On-the air ham radio facilities will be provided by the U.S. Navy's Washington voice in the amateur radio fraternity, K4NAA, operating daily from the Sheraton Park Hotel in Washington, D.C. during the three days of the Armed Forces Communication and Electronics Association Convention in June. AFCEA convention delegates with amateur radio licenses are invited to take advantage of the Navy's ham radio station to contact friends during the convention on June 2, 3, and 4.

The K4NAA fixed portable station will be operational from 0900 to 2200 EDST with two available positions for cw, ssb, and RTTY on the 10-, 15-, 20-, 40-, and 80-meter bands.

A specially designed QSL card has been prepared to acknowledge contacts with licensed amateurs throughout the world who are invited to make contact during the AFCEA convention.

The Navy and AFCEA invite all amateur radio enthusiasts to visit K4NAA on June 2, 3, and4.

—···—

Feedback

There is a dimensional discrepancy in the drawing of the 2-meter repeater antenna shown in January, 1970 *QST* page 24. The 18½-inch dimension is the length of the pipe insert. The 19¾-inch dimension is correct for the stub length. Thanks to W9OFL for calling this to our attention.

—···—

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Celebrating Our Legacy

The Walter Ashe Novice station from the September 1953 issue of *Radio and Television News*.

Getting Started with CW

In the spring of 1953, I was about to graduate from eighth grade. My Novice license had arrived in the mail, but I had no equipment or practical knowledge about ham radio.

One of my father's coworkers used to be a shortwave listener and had a Hallicrafters SX-62A multiband radio receiver he wasn't using, so he lent it to me.

The SX-62A was the most beautiful piece of equipment I had ever used. It had 16 vacuum tubes and a huge front frequency-select face. It was heavy — 65 pounds. Because it was designed for listening to shortwave radio stations, it had no fine-tuning (band-spread) control. The ham frequencies were a tiny segment on the dial — the entire 80-meter band was only 1 inch wide, and as a Novice I could only use a tenth of that space. But the SX-62A did have a CW position for copying Morse code.

We set the radio on a table in our enclosed back porch, and I strung a wire out of the window and up into our attic for an antenna. Every evening I could hear ham stations loud and clear. My Morse skill was getting better — I heard new Novice hams like me, located nearby and around Chicago.

My father and I went to a store in Chicago that sold World War II military surplus electronic equipment, and we bought a radio headset and a J-38 telegraph key, both brand new and in their original boxes. These bargain electronic parts stores had sold joint Army Navy (JAN) 1625 vacuum tubes for 25 cents each, new 811A generators for $1, and brand new ARC-5 radios in the box for $5.

My dad and I built a simple one-tube transmitter using some parts from an old table radio and other parts donated by our ham neighbor. The design was from a Novice project described in a 1952 issue of *CQ Amateur Radio* magazine. It had a single cathode-keyed 6L6 tube, used my 80-meter crystal, and had a surplus 0-250 mA meter for tuning. Our ham neighbor checked it out for me — it put out 8 W!

Roy Rusin, W6II
Saint George, Utah

Playing Radio

The Christmas of 1956 came 3 days after my 15th birthday. More than anything else, I wanted to be a ham radio operator, so I wanted a shortwave receiver.

I discovered ham radio in the fourth grade when I saw a friend's basement, which had one whole wall covered in large metal boxes with dials and meters on them. I was told it was a ham radio station, but was never given a demonstration of it. As a Boy Scout, my Scoutmaster (who was also my dad) taught me Morse code. He had learned it in pilot training during World War II.

I knew that copying code was the first requirement, and so I wanted that shortwave receiver. On Christmas morning, there was a large box under the tree for me from Walter Ashe Radio in St. Louis, Missouri. When I opened it, I was confused and disappointed to find three small aluminum chassis and a lot of parts. Each set came with four pages of instructions and a wiring diagram — one each for the power supply, receiver, and transmitter. I would have to build my radio. But at least I would have a complete station when (and if) I built it.

That Christmas afternoon, a neighbor called to ask if I was using my radio because her TV was acting strangely. The radio was still in the box, in kit form. I had my first TVI complaint!

Not knowing a resistor from a tube socket, I somehow got the rig built. And, it worked on the first try! I spent hours listening to hams and coastal traffic stations to practice copying code. At first, I could only hope to find someone slow enough that I could pick out just one character.

I hooked the transmitter up to a 40 W lightbulb and spent many happy hours making imaginary contacts using made-up call signs. My sending speed far outstripped my receiving ability. Knowing now what I know about the dummy load characteristics of a lightbulb, I was probably being heard all around town, if not farther!

Dave Sublette, K4TO
Winchester, Kentucky
Life Member

The Hallicrafters SX-62A shortwave receiver.

Send reminiscences of your early days in radio to "Celebrating Our Legacy," ARRL, 225 Main St., Newington, CT 06111 or **celebrate@arrl.org**. Submissions selected for publication will be edited for space and clarity. Material published in "Celebrating Our Legacy" may also appear in other ARRL media. The publishers of *QST* assume no responsibility for statements made in this column.

Russ Sutton, W3MY, mrmedia35@gmail.com

Classic Radio

The History of Collins Radio

Over time, brands become iconic for their superb engineering, remarkable dependability, and unequalled style. One of the most iconic brands in radio is Collins Radio Company. From military and amateur radio equipment to flight navigation and space communications, Collins Radio has always been a leader in its field. The reasons for the company's success are found in its history.

Lead photo — Gold Dust Twins. [Gary Halverson, K6GLH, photo]

The 1920s

At just 9 years old, Arthur A. Collins formed his first station with a Quaker Oats box as a tuning coil and a Ford Model T spark coil. In 1923, at age 14, Collins earned his radio license from the Federal Radio Commission, before it became known as the Federal Communications Commission (FCC). His call was 9CXX.

The following year, Collins found notoriety through his communication with the MacMillan Expedition in Greenland, using his own equipment. Having the exclusive means to talk with the expedition each night brought him nationwide fame.

His reputation grew when he wrote about the schematics for a CW transmitter and various oscillator circuits for the May 1926 issue of *Radio Age*. In the summer of 1927, Collins, as 9ZZA, conducted mobile experiments in conjunction with the US Naval Observatory (USNO) in Washington, DC. The stage was set for him to begin designing and building amateur radio equipment.

The 1930s

Collins wanted to change the design of "breadboard" nests of wires to solid pieces of equipment with hard wiring and metal craftsmanship fit for desktop display. For the first time, amateur equipment featured quality components, fine engineering, and sound wiring that would last for years.

Collins' business began with an ad in the January 1932 issue of *QST*, featuring a CW transmitter kit starting at $37.25. The tagline read, "The smoothest, neatest little rig you ever saw — and what a Kick she has." At the time, the units were constructed in the basement of his home.

The first assembled and tested Collins gear available to hams was a 30 W, crystal-controlled transmitter with plug-in coils, featuring a Bakelite front panel with a steel chassis. It included the hallmarks of all Collins Radio products to come — advanced engineering, resilient construction, professional displays, and sound performance.

Following the success of the 30 W transmitter was a cavalcade of transmitters during the 1930s: the 150 series; 40A/B; tuners labeled 2A, 2B, 2C, 32A, and 32B for CW and AM; 4A; 30FXB; the extremely popular 45A, 32FX, 32G, 32FXC, 32FXR, and the 30J, which was the last transmitter design before World War II.

Collins Radio Company catapulted into the national spotlight after Richard E. Byrd's 2nd expedition to Antarctica in January 1934. A headline in the *Collins Signal* newsletter (published by Collins Radio) read, "The Byrd Antarctic Expedition II Sails With A Complete Collins Short Wave Broadcasting Station Aboard!" The Collins 20B transmitter was the 6,000-mile link that shared the progress of Byrd's expedition with the world, through a relay connection with CBS News Radio in New York.

The 1940s

With the completion of the 30J transmitter in the late 1930s, Collins retooled for war production with the construction of its main facility in Cedar Rapids, Iowa in 1940. During this period of growth, many of his engineering feats were accomplished: including the AN/ART-13 transmitter, autotune system, permeability tuned oscillator (PTO), resnatron, and cyclotron.

The AN/ART-13 with autotune was an extremely popular transmitter, especially among the United States Army Air Corps (USAAC). Its hallmark was the autotune system, designed to prevent tedious retuning

of the transmitter with each change in frequency. The engineers designed an automated mechanical system of rotating tuning shafts to match the transmitter to the desired frequency.

The PTO was Collins' next landmark development. It was designed by Ted Hunter at Collins Radio to create a more stable variable frequency oscillator (VFO). The PTO incorporated a variable inductance for tuning using a ferrite rod that screwed in and out of a tuning coil. It was introduced in the AN/ART-13 transmitter in 1945.

The 1950s

The 1950s was a period of expansive production of iconic amateur radio equipment. In addition, Collins created many "firsts" with military radios. The company launched a two-box system of desktop ham transmitters and receivers called the "A line." Many know the 75A-3 receiver and the KWS-1 kWh SSB/CW transmitter as the "Gold Dust Twins." The two units were cabled to act as one, which was new in the field of amateur radio electronics (see the lead photo).

Taking it one step further, Collins combined two boxes (transmitter and receiver) into one unit called the KWM-1 "transceiver," which could be used in mobile settings. It was used in U2 spy planes and many other military applications.

An SSB airborne system was proposed by Collins to General Curtis LeMay as a means of solving the Strategic Air Command's (SAC) problem of connecting all SAC aircraft and land bases around the world using HF frequencies.

Another first during the 1950s was when Collins Radio entered the world of space communications with its navigational equipment for Project Mercury. The equipment was designed to cover voice, telemetry, rescue, tracking, and command functions of the space missions.

The 1960s

Highlighting Collins' product line in the 1960s was the S-Line. It was a replacement for the famous A-Line and Gold Dust Twins series of transmitters and receivers. Like the two-box desktop series before it, the S-Line transmitters and receivers could operate jointly like a transceiver or separately. Included in the design was the famous S-Line PTO (70K2). Additional components included the 30L-1 linear amplifier, 62S-1 transverter for 6 and 2 meters, 312B-4 console, and the 312B-5 VFO.

Advancements were made in the 1960s with the KWM-1 transceiver, resulting in the new KWM-2/2A radio. Power input was 175 W PEP on SSB or 160 W on CW, and operated on 80 through 10 meters.

Production of space communications from the previous decade continued with the Apollo missions. Collins provided the data and communications equipment. There were S-band transceivers, VHF transceivers, astronaut-to-astronaut systems, and various other equipment.

Although Collins became renowned for its surface applications of mobile and land-based radios, they also developed the AN/URC-32 for submarines. The rig became the fleet's primary communication system once SSB replaced AM.

A relatively unknown development in Collins Radio was its takeover battle with Ross Perot because of the Collins Radio "C-System" computer program putting financial stress on the company. Eventually, in early 1969 when Collins stock had fallen, Ross Perot tried to merge Collins Radio with his Electronic Data Systems company. However, the takeover failed because banks felt his company was too small.

The 1970s

During this process, the banks learned the depth of Collins' financial woes. They determined that Collins spent too much of its assets on research and development, especially on its computer system.

This convinced Arthur Collins that he needed a financial partner. In 1971, North American Rockwell invested $35 million in Collins Radio and won the right to choose most of its board members.

During this time, they developed a series of advanced radio equipment, including the 100 W KWM-380 transceiver released in the fall of 1979, which replaced the KWM-2.

Collins Today

Collins Radio became Rockwell Collins and operated as such for 17 years, until United Technologies acquired them in 2018. Today, the company is called Collins Aerospace, reflecting its emphasis on space and flight electronics. According to a Collins Aerospace representative, the company no longer produces amateur radio equipment. However, the Collins Radio legacy will endure for years to come.

For more information and a list of sources, visit **www.k4vrc.com/uploads/7/8/8/6/78865320/collins_history_presentation_tvarc_9-21_[w3my_russ].pdf**.

Strays

Maritime Radio Day April 14 and 15

Maritime Radio Day is a celebration of nearly 90 years of the maritime wireless service. Open to all amateur radio stations, it will begin April 14 at 12:00 UTC and end April 15 at 22:00 UTC. You'll find complete details at **trafficlist.altervista.org/mrd/**.

Al Brogdon, W1AB

100, 50, and 25 Years Ago

March 1920

- The cover artwork shows a ham shack far removed from the house, with a ham making the most of the atmospheric quiet of the winter months.
- The editorial announces that *QST* will no longer be available by subscription to non-members. Henceforth, ARRL membership and subscription to *QST* are one and the same.
- F. H. Schnell and R.H.G. Mathews discuss "Radio Club Organization," pointing out the need for local organization of amateurs in a manner that meshes with our national organization.
- The Old Man describes the "Rotten Hours" he has to keep to get all his messages sent.
- The editor shares a method of "Minimizing QRM" that was developed during the Great War, when it was successfully used by American and British forces. It uses a wave-trap circuit and has become known as "the red plug."
- A. Groves, who concentrates his radio efforts on improving receiving circuits, presents his thoughts "On the Use of Honey-Comb Coils."
- ARRL Traffic Manager J.O. Smith recounts his experiences during "A Little Journey" that took him through 20 states, as he visited prominent radio amateurs.
- B.B. Skeete discusses the use of "Telephone Jacks in Amplifiers."
- "A Dutch Amateur Valve" reviews the first Dutch-made amateur tube, made by the Philips Lamp Works, comparing its performance with that of American tubes.

March 1970

- The magazine cover shows Doug DeMaw's, W1CER, QRP 80- and 40-meter transceiver, described in this issue.
- The editorial notes that this is the first issue of *QST* produced by the new IBM composition equipment at Headquarters.
- Rudolf Fischer, DL6WD, presents a description of his slightly unconventional homebrew solid-state receiver, in "An Engineer's Ham-Band Receiver."
- Wayne Overbeck, K6YNB, discusses "High Versus Low Antennas," and shares the results of performance tests using identical arrays at different heights.
- Katashi Nose, KH6IJ, outlines "A Simple Safety Feature for Crank-up Towers."
- Lewis Collins, K4GGI, talks about "The K4GGI 220-MHz Kilowatt Amplifier."
- John Daebelliehn, WN9BJC, explains how to build "A Two-Element 15-Meter Quad for the Novice."

March 1995

- The cover photo montage portrays several aspects of ham radio at this time, including the 40th anniversary of the San Bernardino Microwave Society.
- The editorial notes that amateurs are now on the verge of instant licensing.
- In "A Journey to the Center of Asia," Terry Langdon, W6/G3MHV, shares how a business trip across Russia allowed him to do some DXing from Tuva (in Zone 23), while learning about this little-known country.
- Jim Ford, N6JF, describes how he built "A 'Rope Ladder' 2-Meter Quagi" that is 100 feet long, and "gets out like gangbusters."
- Ben Spencer, G4YNM, reports on building "An Audio Break-Out Box" that takes one audio output to provide four identical outputs for various accessories.
- Ulrich Rohde, KA2WEU, tells us how we can use off-the-shelf phase-lock-loop (PLL) and direct digital synthesis (DDS) parts with a pair of voltage-controlled oscillators (VCO) to build "A High-Performance Hybrid Frequency Synthesizer" that outperforms the synthesizers in current commercial ham gear.
- Gary Diana, N2JGU, urges readers to "Try Building Your Own Equipment" from *QST* articles.

Silent Keys

It is with deep regret that we record the passing of these radio amateurs:

K1DXA **Bittel**, Philip W., Torrington, CT
N1GDY **King**, Dennis F., Upton, MA
AG1M **Mildenberger**, Edmund John, Brighton, CO
K1MAA **Fascione**, Frank J., Tolland, CT
N1RJS **Skinner**, Richard J., Mooresboro, NC
W1RY **Bintliff**, Raymond P., Acton, MA
WA1UNQ **Calkins**, Richard A., Glocester, RI
W1VCU **Denison**, Nelson C. "Denny," Bowie, MD
N1WSG **Britland**, Glenn H., Seekonk, MA
W1YN **Goodhue**, Edward W., Jr., Bourne, MA
NS2A **Kennedy**, William C., Barrington, NJ
WB2ASH **Hall**, James E., Philadelphia, NY
N2BO **Brady**, Walter C., Jr., Edwards, NY
KB2DPD **Musella**, Gerard, Elmont, NY
N2FER **Brummer**, Ann E., Queensbury, NY
•WB2GIU **Dwyer**, John F. "Jack," Averill Park, NY
♦K2GPL **Geiger**, Everett A., Upper Saddle River, NJ
KN2L **Fort**, Robert G. "Jerry," Sr., Hamilton, NJ
AA2LN **Koble**, Ned A., La Follette, TN
WA2PVK **Mansey**, William F., Largo, FL
AD2Q **Rife**, David Charles, Port Saint Lucie, FL
KG2Q **Skelly**, Donald F., Jr., Sauquoit, NY
KJ2Q **Rajchel**, John W., New Hartford, NY
K2RA **Rager**, Donald M., Jr., Buffalo, NY
N2RGR **Dey**, Virgil C., York, SC
KB2SHD **Collignon**, Harry R., Jr., Larchmont, NY
WB2YRH **Cotriss**, Donald P., Waterford, NY
KC3AWE **Snyder**, Donald C., Mount Joy, PA
•K3BLJ **Shade**, Keith N., Findley Lake, NY
K3CHR **Wright**, John E., Lafayette Hill, PA
K3CLD **Dorian**, Charles L., Wheaton, MD
KN3E **Hoeck**, Edwin B., Jr., Heathsville, VA
K3FXX **Matland**, Danielle S., Marathon, FL
K3GPS **Binkley**, James G., Lewisberry, PA
N3KSB **Arnold**, Dean E., State College, PA
•N3MI **Nemeth**, Robert A., Salisbury, NC
KY3O **Tucker**, John A., Westview, KY
W3PJL **Jones**, Larry D., Nokomis, FL
KE3RE **Palmer**, William J., Jr., Charlotte Hall, MD
KA3TDQ **Sciulli**, Joseph D., Jr., Mount Washington, PA
N3USB **King**, Walter J., Glen Burnie, MD
W3WFM **Milligan**, William F., Upper Marlboro, MD
•N3WUC **Sciulli**, Mary Ann, Mount Washington, PA
KB3WVO **Weidner**, Robert L., Greenville, PA
•KE4AFK **Palmrose**, Kimberly S., Altha, FL
•K4AKA **Anderson**, Eugene, Mountain Grove, MO
WA4AKJ **Roach**, D. Joe, Cresview, FL
N4CFA **Austin**, John M. "Jack," Farmville, VA
W4CGC **Hallfors**, Dana J. "Finn," Asheville, NC
KY4COE **Coe**, John C., Bowling Green, KY
KK4DEO **Will**, Woodrow W., Cecilia, KY
K4DUB **Campbell**, Dub, Collinsville, TX
♦N4DXS **Veader**, Stephen R., Dale City, VA
WW4EN **Novacek**, Eugene, Tuxedo Park, NY
WB4EZL **Hough**, Frances C., Macon, GA
K4GEJ **Abbott**, Earl T., Jr., Roanoke, VA
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K4HZE **Laurer**, George J., Wendell, NC
•KJ4KEW **Gaddy**, Mary A., Clyde, NC
♦W4KYS **Stitt**, Tony A., Bristol, TN
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KE4NBX **Evans**, Earl E., Jr., Gloucester, VA
N4NCT **Spurlin**, Lewis M., Jr., Durham, NC
KE4NJX **Darby**, Richard, Atlanta, GA
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•N4PWY **Luce**, John W., Tampa, FL
N4PXQ **Baranyi**, Marcia L., Oak Ridge, TN
KD4QQP **McNaughton**, Fritz W., Lancaster, SC
KG4SNN **Latta**, David S., Midlothian, VA
♦W4TTS **Hames**, Ann H., Shelby, NC
KJ4TYR **Smith**, James W., Heathsville, VA
♦WB4WXP **Fountain**, Collier J., Sopchoppy, FL
W4YWH **Blocher**, Harold F., Sr., Highland Heights, KY
AB5AR **Kimbrell**, Virgil C., Columbus, MS
KB5CSQ **Byrd**, Betty, Gulfport, MS
K5DAH **Poirrier**, Louie, Pasadena, TX
KB5DRD **Carpenter**, Kenneth R., Nettleton, MS
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KC5LCQ **Bellamy**, James D., Ponder, TX
K5MET **Brewer**, Tom C., Carrollton, TX
KF5MWE **White**, Gary R., Quitman, MS
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KJ6HJN **Reyes**, Carrie L., Orland, CA
KD6JSM **Philibert**, Larry G., Redlands, CA
N6LHX **Stembridge**, James E., Pagosa Springs, CO
WB6LRN **Pierce**, David E., Lompoc, CA
KB6RSW **Lee**, James C., Sr., Yucaipa, CA
•W6RYD **Kline**, Leonard, Solana Beach, CA
AE6SX **Pruitt**, Dan, Fresno, CA
•WA6TIB **Lopes**, Antonio P., Modesto, CA
WB6VKR **Gunderson**, Art, Santa Paula, CA
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KB8BK **Ridgeway**, Harley D., Belding, MI
W8COC **Goddard**, Daniel R., Jr., Garden City, MI
•N8DYE **Harris**, Jim, Mansfield, OH
•W8HYX **Comstock**, David W., Hurricane, WV
WA8JKG **Cummons**, Jon, Lewis Center, OH
KD8LZW **Adams**, Allan J., Lincoln Park, MI
KB8MNE **McClaren**, William E., Salem, OH
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WW8T **Munski**, Gregory J., Grand Rapids, MI
KB8UXX **Harvey**, Michael E., Saint Marys, OH
♦K8WWX **Werner**, Roy W., Columbiana, OH
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AK0BG **Boyvey**, Don E., Des Moines, IA
KY0F **Paul**, Eddy S., Lenexa, KS
N0GTW **Plumb**, James, Loveland, CO
♦K0IVO **Grossman**, Erwin H., Saint Louis Park, MN
WB0MNP **Weiskopf**, Kevin R., Union, MO
KD0UIK **Murphy**, Stephen, Stevens Point, WI

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For information on how to list a Silent Key in *QST*, please visit **www.arrl.org/silent-key-submission-guidelines**.

Note: Silent Key reports must confirm the death by one of the following means: a copy of a newspaper obituary notice, a copy of the death certificate, or a letter from the family lawyer or the executor. Please be sure to include the amateur's name, address, and call sign. Allow several months for the listing to appear in this column.

Many hams remember a Silent Key with a memorial contribution to the ARRL Foundation or to ARRL. If you wish to make a contribution in a friend or relative's memory, you can designate it for an existing youth scholarship, the Jesse A. Bieberman Meritorious Membership Fund, the Victor C. Clark Youth Incentive Program Fund, or the General Fund. Contributions to the Foundation are tax deductible to the extent permitted under current tax law. Our address is: The ARRL Foundation Inc., 225 Main St., Newington, CT 06111.

Strays

QST Congratulates...

Bryant Rascoll, KG5HVO, on achieving the rank of Eagle Scout. An ARRL member, Bryant was honored in a ceremony last December in Montgomery, Alabama. One of the Troop 307 leaders, David Pinkston, is shown doing the honors.

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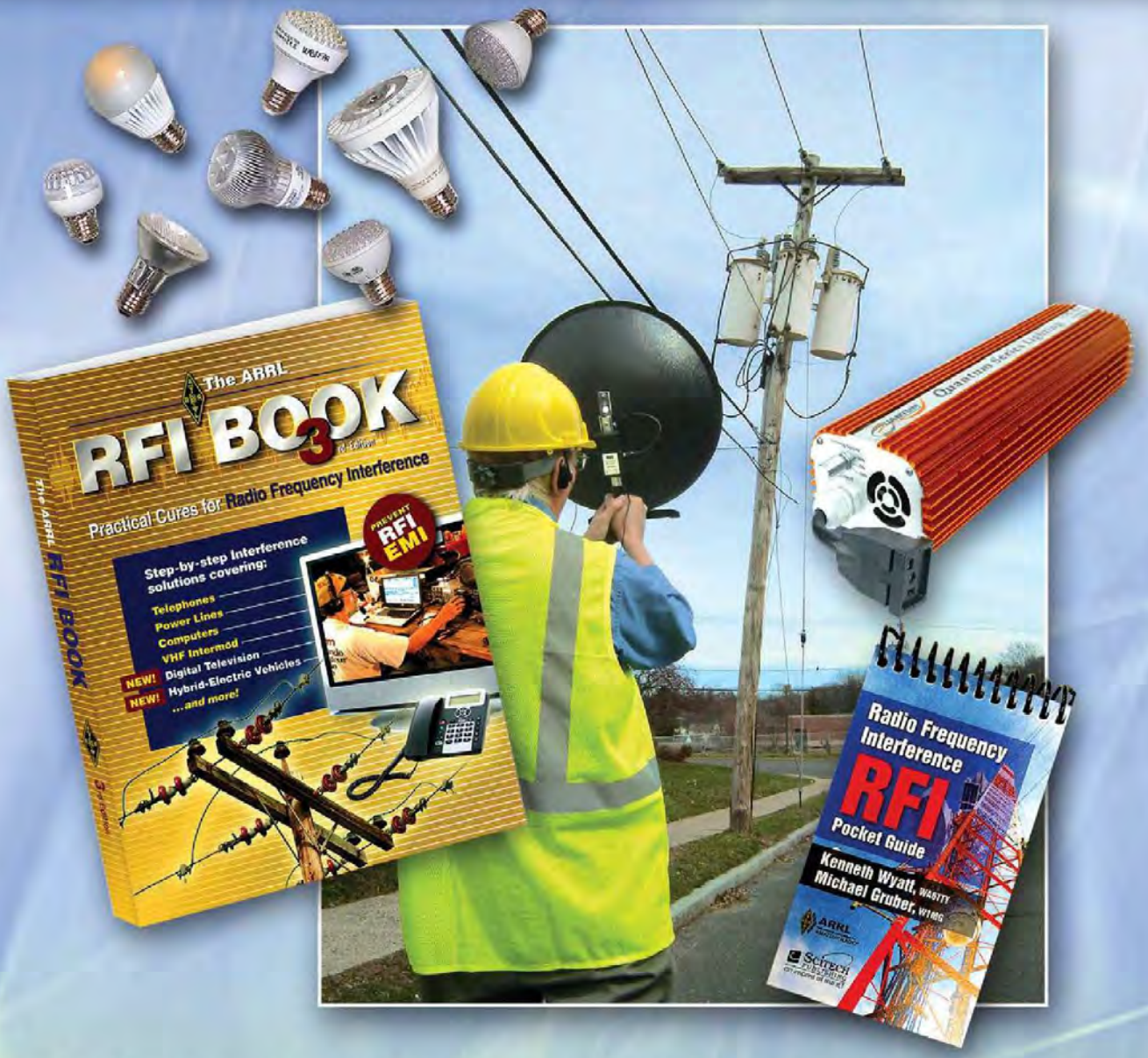

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For medium communications arrays up to 15 square feet wind load area. Has 5-second brake delay, Test/Calibrate function. Low temperature grease permits normal operation down to -30 degrees F. Alloy ring gear gives extra strength up to 100,000 PSI for maximum reliability. *Precision* indicator potentiometer. Ferrite beads reduce RF susceptibility. Cinch plug plus 8-pin plug at control box. Dual 98 ball bearing race for load bearing strength and electric locking steel wedge brake prevents wind induced movement. North/South center of rotation scale on meter, low voltage control, max mast $2^{1}/_{16}$".

HAM-VI – $809.95 with DCU-2
HAM-VII – $959.95 with DCU-3

Specifications	
Wind Load Capacity (inside tower)	15 square feet
Wind Load (w/mast adapter)	**7.5 square feet**
Turning Power	800 in.-lbs.
Brake Power	**5000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Dual race/96 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	26 lbs.
Effective Moment (in tower)	**2800 ft.-lbs**

TAILTWISTER SERIES II – $869.95

For Large Medium Antenna Arrays up to 20 sq. ft. wind load.

Has 5-second brake delay, Test/Calibrate functions. Low temp grease, tough alloy ring gear, indicator potentiometer, ferrite beads on potentiometer wires, weatherproof AMP connectors plus 8-pin plug at control box, triple bearing race with 138 ball bearings for large load bearing, electric locking steel wedge brake, North/South center of rotation scale meter, low voltage control, $2^{1}/_{16}$" max mast. **MSHD, $139.95**. Above tower heavy duty mast support. T2X, HAM-IV, HAM-V, HAM-VI. Accepts $1^{7}/_{8}$-$2^{5}/_{8}$" OD.

T-2XD2 – $979.95 with DCU-2
T-2XD3 – $1039.95 with DCU-3

Specifications	
Wind Load Capacity (inside tower)	20 square feet
Wind Load (w/mast adapter)	**10 square feet**
Turning Power	1000 in.-lbs.
Brake Power	**9000 in.-lbs.**
Brake Construction	Electric Wedge
Bearing Assembly	**Triple race/138 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	31 lbs.
Effective Moment (in tower)	**3400 ft.-lbs**

CD-45II – $499.95

For antenna arrays up to 8.5 sq. feet mounted inside tower or 5 sq. ft. with mast adapter.

Low temperature grease good to -30 F degrees. New Test/Calibrate function. Bell rotator design gives total weather protection, dual 58 ball bearing race gives proven support. Die-cast ring gear, stamped steel gear drive, heavy duty, trouble free gear train, North center scale, lighted directional indicator, 8-pin plug/socket on control unit, snap-action control switches, low voltage control, safe operation, takes maximum mast size to $2^{1}/_{16}$ inches. MSLD light duty lower mast support included.

CD-45D2 – $599.95 with DCU-2
CD-45D3 – $659.95 with DCU-3

Specifications	
Wind Load Capacity (inside tower)	8.5 square feet
Wind Load (w/mast adapter)	**5.0 square feet**
Turning Power	600 in.-lbs.
Brake Power	**800 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/48 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**8**
Shipping Weight	22 lbs.
Effective Moment (in tower)	**1200 ft.-lbs**

New!

Hy-Gain Programmable DCU-3 Digital Rotator Controller

DCU-3 – $499.95

Hy-gain DCU-3 Digital Controller lets you program 6 beam headings! Gives you full automatic or manual control of your hy-gain HAM or Tailtwister Rotators.

Press a memory button or dial in your beam heading or let *Ham Radio Deluxe* (or other) take control. Your antenna auto rotates precisely and safely to your DX.

DCU-3 automatically jogs your antenna free and safely unlocks it before rotating begins (*great for older rotators with "sticky" brakes*) then turns off your motor before reaching its final heading. Your antenna gently coasts to a stop before the brake re-locks -- greatly reducing damaging overshoots and extending rotator life.

Simply press *Left* and *Right* buttons for full manual control and fine tuning.

Bright blue LCD shows current, dialed in and computer controlled beam headings in one degree increments and your call.

Calibrate lets you accurately match your display to your true beam heading. Has USB/RS-232 ports for computer control. Adjustable LCD sleep time. Field upgradeable firmware. 8.5Wx4.3H x9D".

110 VAC. Order DCU-3X for 220 VAC.

DCU-2 Digital Rotator Controller – $459.95
Like DCU-3, but less programmable memories. 110 VAC.
Order **DCU-2X**, for 220 VAC.

AR-40 – $399.95

For compact antenna arrays and large FM/TV up to 3.0 square feet wind load area.

Dual 12 ball bearing race. Automatic position sensor never needs resetting. Fully automatic control -- just dial and touch for any desired location. Solid state, low voltage control, safe and silent operation. $2^{1}/_{16}$ inch maximum mast size. MSLD light duty lower mast support included.

AR-40 Rotator Specifications	
Wind Load Capacity (inside tower)	3.0 square feet
Wind Load (w/mast adapter)	**1.5 square feet**
Turning Power	350 in.-lbs.
Brake Power	**450 in.-lbs.**
Brake Construction	Disc Brake
Bearing Assembly	**Dual race/12 ball bearings**
Mounting Hardware	Clamp plate/steel U-bolts
Control Cable Conductors	**5**
Shipping Weight	14 lbs.
Effective Moment (in tower)	**300 ft.-lbs**

Replace your Yaesu Rotator Controller

YRC-1 – $369.95

Hy-gain YRC-1 -- more features, more robust, far less prone to lightning damage. Costs less than repairing!

Easy-to-use -- dial in your beam heading and tap GOTO button. Exclusive 180 degree *AutoReversal*™ for fast longpath operation. All DCU-2 features. Bright blue LCD shows current, dialed-in, computer controlled beam headings, call. USB port for computer control. Extra heavy-duty AC power supply. Fast variable DC motor minimizes overshoot. Intuitive menu. Field upgradeable. For Yaesu G-800/1000/2800/G450/650. AC or DC motors.

YRC-3, $449.95. Like YRC-1 and adds 6 memories.

AR-500 Rotator/Controller – $169.95

UHF/VHF/6-Meter, MFJ-1886 Rotator/Controller and Remote. For use of small VHF/UHF, 6M, TV, FM, the MFJ-1886 wide band receiving loop and other light-weight ham antennas. Rotator is built in a weather-proof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote, clamps, and all hardware.AR-500 remembers up to 12 directions even after a power outage! Use remote control or direct console. Displays location and relative position.

hy-gain® Antennas, Rotators & Towers 308 Industrial Pk Rd, Starkville, MS 39759 USA
Sales/Tech: (662) 323-9538 ■ **FAX:** (662) 323-5803 Open 8-4:30 CST, Mon.-Fri.

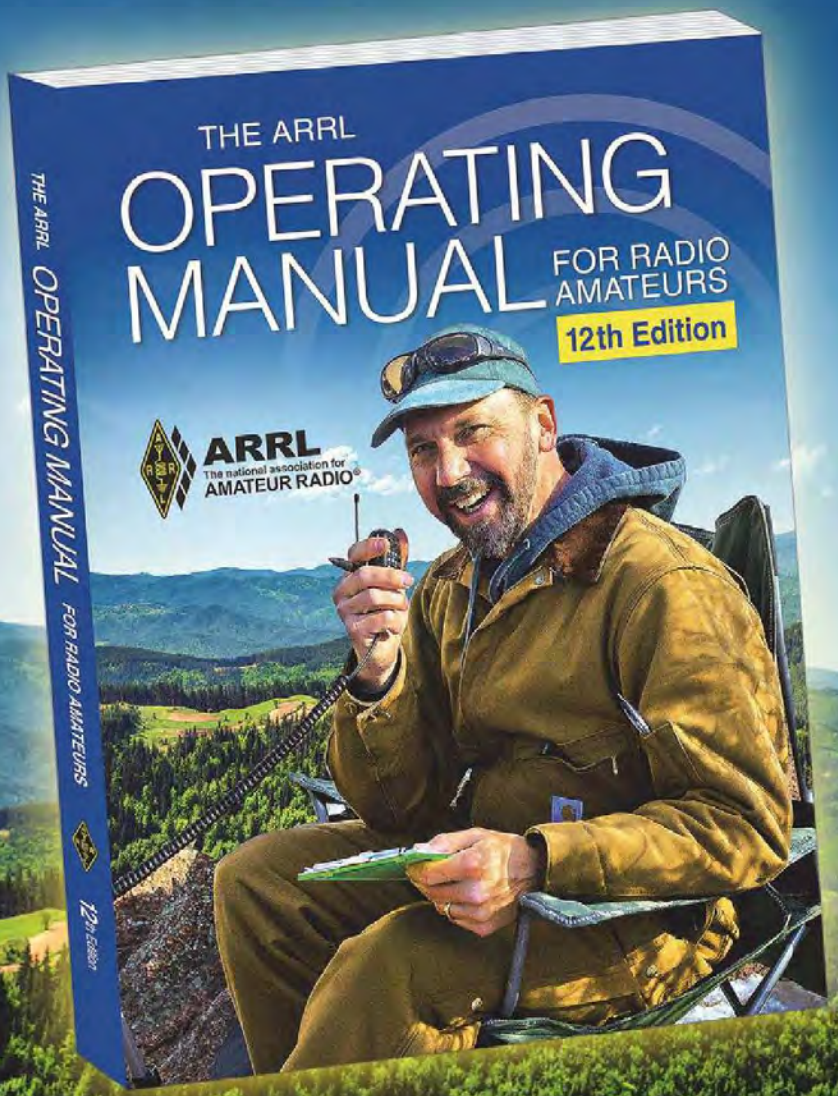
NEW 12th Edition

The ARRL Operating Manual

Your Guide to On-Air Operating Activities

Talking to friends. Serving your community. Chasing DX. Adding a new band. Trying a new mode. Working a contest. Taking your radio on the road or out in the field. These are just a few of the exciting and fun on-air operating activities to try once you have earned your license and mastered the basics.

The ARRL Operating Manual is as a comprehensive guide to amateur radio operating. This edition has been updated by experienced hams who are active on the air. They are happy to share what they have learned so that you can get involved and on the air too.



Get On the Air!

- Learn basic operating procedures and how to set up your station.
- Become an active ham, contact radio amateurs around the world.
- Join a local radio club and enjoy amateur radio group activities.
- Volunteer your radio skills to serve your community.
- Participate in contests, and earn operating awards.

Includes new material on FT8 and other *WSJT-X* digital modes.

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MFJ *Magnetic Loop* Antennas

MFJ 36-inch magnetic loop antenna lets you operate 7 to 22 MHz or 10 to 30 MHz continuously -- including the WARC and MARS bands! Easily handles a full 150 Watts on SSB/CW/Digital for any transceiver.

Ideal for limited space -- apartments, small lots, motor homes, attics, or mobile homes.

Work exciting DX with low angle radiation and local close-in contacts with high angle radiation when mounted vertically.

Super easy-to-use! MFJ remote control auto tunes to your desired band. Fast/slow tune buttons, Cross-Needle SWR/Wattmeter lets you quickly tune to your exact frequency. No control cable needed.

***World's** most efficient small loop antenna has all welded construction, welded butterfly capacitor with no rotating contacts, large 1.050 inch diameter aluminum radiator -- gives you highest possible efficiency.*

Every capacitor plate is welded for extremely low loss and polished to prevent high voltage arcing. Nylon bearing, anti-backlash mechanism, limit switches, continuous no-step DC motor gives smooth precision tuning. Heavy-duty ABS plastic housing has ultraviolet inhibitor protection.

MFJ-1782, $459.95. Like MFJ-1786 but with fast/slow tune manual remote control.

MFJ-1780, $369.95. 20-10 Meters, 150 Watt *Portable* *24x24x24" box fan loop with carrying handle.* Highly efficient all-welded contstruction, no-rotating contact butterfly capacitor. Fast/slow tune remote control. No control cable needed. *See QST July 2019 review.*

MFJ-1780XX, $449.95. Like MFJ-1780 with auto band tune remote control, SWR/Wattmeter.

Build your own Mag loop!

Motorized Butterfly Capacitors

Super low loss butterfly capacitors, no rotating contacts, all plates welded with no mechanical electrical contacts. Anti-backlash mechanism. DC motor with gear reduction box. Handles at least 150 Watts SSB/CW/Digital.

1. **p/n: 282-1786, $189.95.** 11-128 pF.
2. **p/n: 282-1788, $249.95.** 15-260 pF.
3. **p/n: 80-1786-2SM, $249.95.** Auto band selecting remote controller with SWR/Wattmeter.
4. **p/n: 80-1782-2, $79.95.** Manual remote control, fast/slow tune buttons.

Butterfly Capacitors

5. **MFJ-19, $79.95.** 12-67 pF.
6. **MFJ-23, $109.95.**18-136pF.
7. **p/n: 729-0142, $19.95.** 6:1 vernier gear reduction drive for loop tuning capacitor.

8. 36-inch Aluminum Circular Loop with Integrated welded capacitor and mast mounting brackets
p/n: 10-1786-11, $129.95. 1.05 inch OD heavy duty tubing.

See MFJ Youtube reviews at: *https://m.youtube.com/results?search_query=mfj*

MFJ Magnetic Loop Tuners, 150 Watts

Turns any wire loop into a small, high efficiency multi-band transmitting magnetic loop antenna! Work the world on 3.5 to 30 MHz with a full 150 Watts SSB/CW/Digital. No ground, radials or counterpoises needed. Very quiet receiving antenna -- you'll hardly notice static crashes. High-Q reduces QRM, overloading, harmonics. Perfect for apartments, antenna restricted areas and portable operation.

A 13' wire loop covers 30-20 Meters (4' for 17-10M; 7' for 20-15M; 28' for 60-40M; 50' for 80M). Tune *any* shape loop -- circle, square, rectangle, *etc.*

A wire length gives about 1.5 to 1 frequency range (i.e.7-10, 18-28 MHz).

MFJ low loss *Butterfly* loop tuning capacitor has no rotating contacts. *Easy-Carry* handle. Mount for PVC Cross loop support on cabinet top.

MFJ-936B, $299.95. Antenna current meter, Cross-Needle SWR/Wattmeter. 9¼Wx5½Hx9½D inches.

MFJ-935B, $249.95. Antenna current meter. 6¼Wx5½Hx9½D inches.

MFJ-933, $209.95.6¼Wx5½Hx9½D".

MFJ Low-Noise Receiving Mag Loop

Clearly hear signals 50 KHz to 30 MHz you never knew existed. Power line noise and static disappears. Rotating MFJ-1886 eliminates interfering signals or greatly peaks desired signals. Excellent antenna and preamplifier balance gives deep null. Gives excellent strong and weak signal performance without overload. Fully protected state-of-the-art push-pull Gali MMICs preamplifier gives you high dynamic range, low IMD and 25 dB of low noise gain. Use inside or outside.

QRP Mag Loop Tuner

MFJ-9232
$69.95

Turns wire around a bookcase, window, tree, etc. *into a small, high efficiency transmitting loop antenna!* Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No counterpoises, radials, ground needed. 25 Watts. Very quiet reception. Hi-Q reduces QRM, overload, harmonics. Great for apartments, antenna restrictions, portable ops.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

Antenna Rotator

Perfect for magnetic loops, VHF/UHF, small HF beams, TV, FM antennas. Weather-proof cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. 12 Memories. Digital display, 110/220 VAC.

AR-500
$169.95

MFJ Tripods/Masts

Strong, black *steel* triangular braced base. Non-skid feet, strong mast locks.

MFJ-1919, $109.95, Supports 100 lbs. Extends a *whopping* 7.8 ft. Base spreads up to 4.8 sq. ft. 1.4" dia. mast. Collapses to 54" by 6" diameter. 9¾ lbs.

MFJ-1919EX, $179.95. Tripod *plus* mast. 18' extended. 5' collapsed. 1/8" wall, 3/4" dia. top, 1½" dia. bottom.15 lbs.

MFJ-1918, $69.95, 6'extended. 38" collapsed, 6¾ lbs.

MFJ-1918EX, $109.95. Small tripod with extension mast. 9½', 3.8 ft. collapsed. ¾"top, 1" bottom. 6.5 lbs.

MFJ Enterprises, Inc. 300 Industrial Pk Rd, Starkville, MS 39759
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MFJ QRP!

QRPocket™ Loop Antenna Tuner

MFJ-9232
$69.95

Drape a wire around a bookcase, window, tree or other object and attach both ends to this *MFJ QRPocket™ Loop Antenna Tuner. It instantly turns into a small, high efficiency multi-band transmitting loop antenna!*

Operate 40-10 Meters with included flexible wire loop (80/60 Meters with your bigger loop). No ground, radials or counterpoises needed. 25 Watts.

It's a very quiet receiving antenna. Its hi-Q reduces QRM, overload, harmonics.

Perfect for apartments, antenna restricted areas and portable operation. Tune *any* shape loop -- circle, square, rectangle, *etc.*

Adjust tuning and matching capacitors for minimum SWR and operate.

BNC for transmitter, wing nut posts for loop wire. Tiny 2¼Wx4Hx2¼D inches.

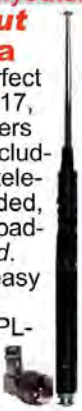
MFJ-9234, $69.95. Like MFJ-9232 but connects directly to your transceiver SO-239 antenna connector.

VIDEOS: https://m.youtube.com/results?search_query=MFJ-9232

QRP Antenna Tuner

MFJ-9201, $59.95. *Tunes any antenna* 80-10 Meters, 25 W. 12-position hi-Q inductor, tune/bypass, variable antenna and transmitting matching capacitors, BNC connectors. Tiny 4Wx2⅝Hx1½D inches -- MFJ-9201, rig and antennas easily fit into a backpack or briefcase for vacation, SOTA, hikes, etc.

MFJ *Walk-About* 80-6M Antenna



MFJ-1899T, $99.95. Perfect for QRP radios like FT-817, KX3, Xiegu, others. Covers *all* bands 80-6 Meters including WARC. Ten section telescoping whip (52" extended, 7" collapsed). 12" base loading coil with *Wander Lead*. Whip/coil unscrews for easy storage. 25Watts. BNC.

MFJ-7703, $8.95, BNC/PL-259 elbow mounts antenna directly on radio.

MFJ Single Band *Walk-Abouts*

Each is 51 inches extended and collapses to 5.5 inches. Handles 25 Watts. BNC.

MFJ-1806T (6M) $34.95
MFJ-1810T (10M) $34.95
MFJ-1812T (12M) $34.95
MFJ-1815T (15M) $34.95
MFJ-1817T (17M) $34.95
MFJ-1820T (20M) $34.95
MFJ-1830T (30M) $44.95
MFJ-1840T (40M) $44.95
MFJ-1880T (80M) $44.95

MFJ HF SSB *Travel Radios*

12-Watts, proven on-air design, hot receiver, analog S-meter, CW option, great sensitivity, 8 poles tight IF filtering, smooth VFO, powerful audio, 15, 17, 20, 40 & 75-Meter models. **$279.95**

Xiegu X5105 5W HF Transceiver

X5105, $599.95. ***Mention this QST ad for $50 off!***

Transmits 160-6 Meters, receives .5 - 54 MHz, all modes:USB, LSB, CW, AM, FM, digital. DSP. Built-in automatic antenna tuner, 3800 mAH battery pack, plots SWR graphically. Deluxe keypad microphone included.

80-10M End-Fed Half Wave Antenna

MFJ-1982LP, $54.95. Get on the air quick! 30W, 132' wire. No tuner needed.

33' Telescopic Portable Mast

MFJ-1910, $99.95. Fiberglass. 3¾ ft collapse, 3.3 lbs.

17' Telescopic Whip

MFJ-1979, $69.95. Stainless steel, collapses to 27".

MFJ *Mini* Switching QRP Power Supply

MFJ-4103, $69.95. Delivers reliable regulated 13.8 VDC at 2.89 Amps (40 Watts) to anywhere in the world (100-240 VAC/47-63Hz input). Overvoltage, over-current, over-temperature protected. Tiny 4⅛x2⅝x1⅜", 10 oz; 2.1 mm ID, 5.5mm OD coaxial DC connector. FT-817 adapter included. **MFJ-5513, $5.95.** 2.1 mm to *PowerPoles™*.

MFJ 500 MHz Dummy Load

MFJ-261, $34.95. Finned aluminum, air-cooled heatsink 50 Ohm dummy load. 100W peak, 15W average. DC to 500 MHz, 1.15:1 SWR. 1⅝" dia. by 3" long.

CW Straight Key

MFJ-550, $19.95. Morse Code straight key. Adjustable spacing and spring tension. Durable plastic base with mounting holes.

SWR/Wattmeter Dummy Load

MFJ-9218, $54.95. Resistive SWR Meter protects output transistors with 3:1 maximum SWR when tuning your antenna. 5/10/20 Watt power ranges. Tune/Bypass switch, BNC input and output connectors. Covers 1.8 to 60 MHz. Rugged tiny case fits any where 4½Wx2¼Hx2¾D".

QRP WattMeter/ Dummy load

MFJ-9214, $39.95. Check *true* QRP output power with this sensitive QRP Wattmeter with *built-in* 50 Ohm dummy load. Also tests battery condition. Reads 5W full scale 1.8-150 MHz. BNC male connects directly to your rig. 2Wx2¼Hx1½D". **MFJ-7737, $6.95.** BNC female to PL-259 adaptor.

QRP SWR/Wattmeter

MFJ-9213, $49.95. Read SWR, forward, reflected power in three ranges: 5, 30, 100 Watts on calibrated meter scale. *Bruene* bridge insures uniform accuracy over 1.8-50 MHz and allows you to leave in-line for continuous monitoring without insertion loss. BNC for transmitter/antenna. 4½Wx2¼Hx2¾D inches.

MFJ *QRPocket* ™ 4:1 Balun

MFJ-9211, $29.95. **4:1** current balun for feeding balanced dipole/antenna to 50 Ohm coax. Binding post, BNC.

Artificial Ground

MFJ-9231, $69.95. **Tune** your counterpoise and ground to greatly increase your radiated power.

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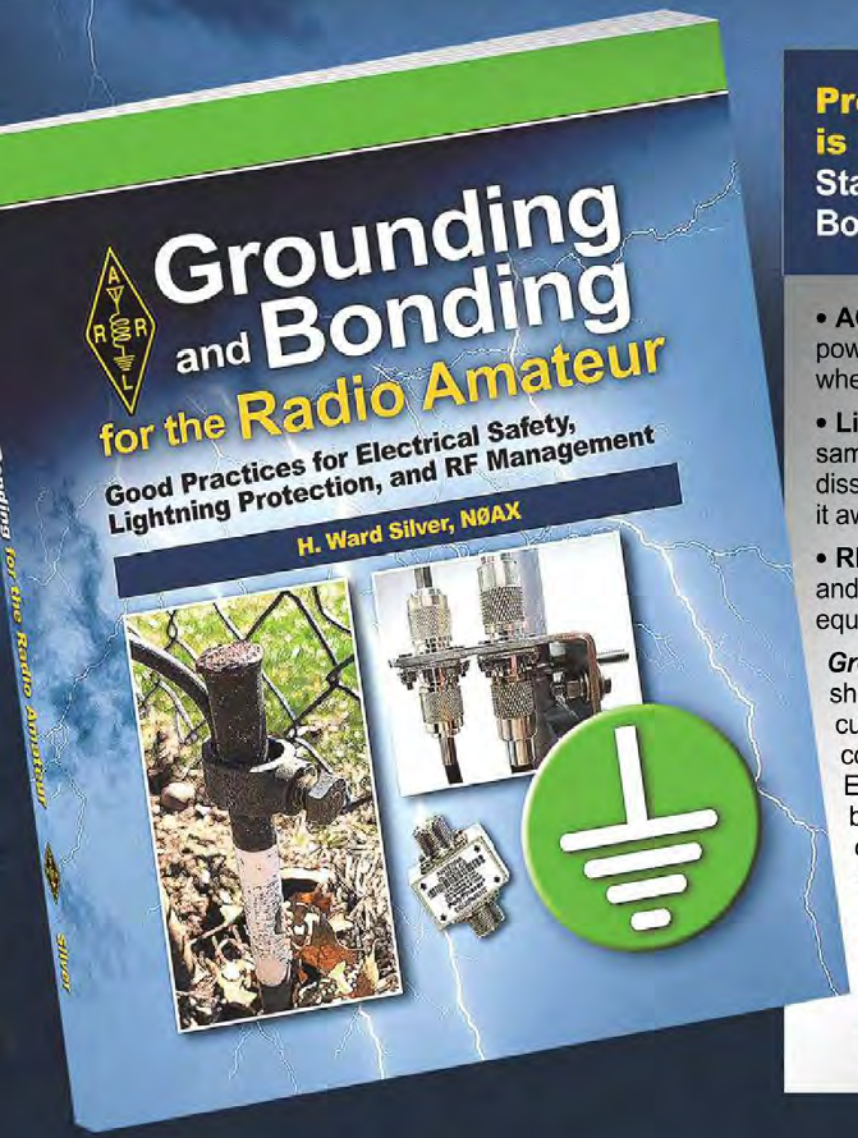
Every Ham Needs This Essential Book!

Grounding and Bonding for the Radio Amateur

H. Ward Silver, NØAX

Good Practices for Electrical Safety, Lightning Protection, and RF Management



Proper Station Grounding is Important!...Build Your Ham Radio Station with Effective Grounding and Bonding Techniques:

- **AC safety:** protects against shock hazards from ac-powered equipment by providing a safe path for current when a fault in wiring or insulation occurs.
- **Lightning protection:** keeps all equipment at the same voltage during transients from lighting and dissipate the lightning's charge in the Earth, routing it away from equipment.
- **RF management:** prevents unwanted RF currents and voltages from disrupting the normal functions of equipment (also known as RF interference or RFI).

Grounding and Bonding for the Radio Amateur shows you how to make sure your station follows current standards for lightning protection and communication systems, not to mention the National Electrical Code. You'll learn effective grounding and bonding techniques for home stations, including condos and apartments, portable and temporary stations, as well as towers and outside antennas.

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QST 2/2019

MFJ Power Supplies

World's best and largest selection of clean, no RF hash, no RFI power supplies designed specifically for ultra-reliable ham radio communications

No Matter What™ Warranty
Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

75-Amps, $289.95

MFJ-4275MV high-current switching power supply gives 75A max/70A continuous. Great for ALS-500M amplifier. Adjustable output 4-16 VDC. 110/220 VAC. Binding posts, quick connects, *PowerPoles*™, cigarette lighter socket on front. Battery charger gives charging current of 20A max, 5A continuous. 9 3/4W x 5 1/2H x 9 1/2D". Only 10.5 lbs.

45-Amps, $169.95

MFJ-4245MV Switching power supply gives 45A surge/40A continuous. 9-15 VDC out. 85-260 VAC in. Low ripple, highly regulated. 5-way posts, cig lighter, quick connects. 5 lbs., 7 1/2W x 4 3/4H x 9D".

25-Amps, $119.95

MFJ-4225MV Switching power supply gives 25A surge, 22A continuous. Adjustable 9-15 VDC output, 85-260 AC input. Large 3" dual Amp/Volt meters, Binding posts, Cigarette lighter socket. 3.7 lbs. 5 1/4W x 4 1/2H x 6D inches.

MFJ *PowerPole*™ Splitters

MFJ-1104, $54.95. *PowerPole*™ Splitter. 30 Amp fused input. Outputs fused at 25, 10, 5A. Open fuse indicator. 2 3/4W x 3 1/4H x 1 1/2D".

MFJ-1107, $59.95. 40 Amp fused binding posts input. 4 fused *PowerPole*™ outputs. Two 2.1 mm center positive power jacks.

MFJ-1106, $49.95. One in, six out *PowerPoles*™ 30A total. 7 sets mating connectors included.

MFJ-4230MV $99.95 30 Amp, 4-16 Volts Adjustable, Volt/Amp Meter, 5W x 2 1/2H x 6D"

Ham Radio's Best Seller!

MFJ-4230MV is ham radio's best selling and most compact switching power supply – just 5W x 2 1/2H x 6 D" and 3 lbs. Takes up little room at your operating position and perfect for home station, Field Day, DXpeditions, camping, hiking, or for your next business trip or vacation.

MFJ-4230MV gives 25 Amps continuously or 30 Amps surge at 13.8 VDC. Voltage is front-panel adjustable from 4 to 16 VDC.

Selectable input voltage of 120 or 240 VAC at 47-63 Hz lets you carry it with you and use it worldwide.

Front-panel rocker switch lets you choose Amp or Volt meter for continuous monitoring. Cool operation with excellent 75% efficiency. Extra low ripple and noise is less than 100 mV.

It's quiet! Continuous air-flow gently cools the power supply and a heat sensor increases the fan speed if the temperature rises above 70 degrees celsius.

Over-voltage and over-current protection fully protects your transceiver and has ALARM LED. DC output is 5-way binding posts on the back so you can power your HF, VHF, UHF transceiver and accessories with ease.

Add a pair of *PowerPoles*™

MFJ-4230MVP, $119.95. *PowerPoles*™ on back.

MFJ-4230MPF, $109.95. *PowerPoles*™ on front.

MFJ-4230DMP, $159.95. Same as MFJ-4230MVP but has bright orange LCD digital volt/amp display.

35-Amps, $149.95

MFJ-4235MV switching power supply gives 35A surge and 30A continuous. 4-16 VDC with 1% voltage regulation, < 9 mV peak-to-peak ripple. AC input 90-125 or 200-240V. 7W x 4 1/4H x 8 3/4D", 4 lbs.

25-Amps, $99.95

MFJ-4125 gives 25A surge, 22A continuous. 13.8 VDC switching power supply has 5-way binding posts on front panel and quick connects on back. 3.5 lbs. Super compact 5 1/2W x 2 1/2H x 5 3/4D inches fits anywhere.

35-Amps, $169.95

MFJ-4035MV *19.2 lb. transformer* delivers 35A max, 30A continuous. 1-14 VDC out, 110 VAC in. Highly regulated, 1% load regulation. 1 mV ripple. 5-way binding posts, quick connects. 9 1/2W x 6H x 9 3/4".

25-Amps, $109.95

MFJ-4125P gives 25A surge, 22A continuous. 13.8 VDC switching power supply front has 2 pair of *Anderson PowerPoles*™ and 5-way binding posts on front. Quick connects on back. 3.5 lbs. Super compact 5 1/2W x 2 1/2H x 5 3/4D".

15-Amps, $79.95

MFJ-4115 Tiny! 17A surge, 15A cont. 13.8 VDC. 110/ 220 VAC. 3 3/4W x 2 1/4H x7 3/4D", 1.5 lb. 5-way posts. Switcher.
MFJ-4215MV, $79.95. 4-16 VDC, 15A surge, 13A cont., backlit volt/amp meters. 90-125V/200-240 VAC. Switcher.

28-Amps, $99.95

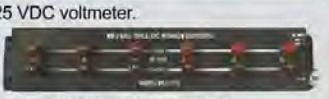
MFJ-4128 28A surge, 25A cont. at 13.8 VDC. AC input voltage 85-135/170-260 VAC. 5-way binding posts, cigarette lighter socket, 7W x 2 1/4H x 7 1/2D", 4 lbs.
MFJ-4218MV, $119.95. 0-24 VDC, 18A@13.8/9A@24 VDC. Backlit V/A meter. 110/220 VAC.

MFJ High Current DC Multi-Outlet Strips

Power multiple transceivers/accessories from a single DC power supply

MFJ-1118, $99.95. Power two HF and/or VHF rigs and six accessories from rig's 12VDC supply. 35A high-current and 15A accessory binding posts. Voltmeter, on/off switch. Master fuse, RF bypass.

MFJ-1116, $69.95. Like MFJ-1118 but 15A total, 8 pairs 5-way posts. "On" LED, 0-25 VDC voltmeter.



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MFJ-1129, $139.95. 10 outlets. Installed fuses: two 1A, three 5A, three 10A, two 25A, one 40A. Outlets 1, 2, 4-8 are PowerPoles™. Outlet 3 is a 35A high current binding post, outlet 9, 10 are 15A binding posts. On/off switch, 0-25 VDC voltmeter. 12 1/2W x 1 1/4H".

MFJ-1128, $129.95. 12 fused *PowerPoles*™: three 1A, four 5A, four 10A, one 25A, one 40A. Switch. Meter.

MFJ-1126, $99.95. 8 fused *PowerPoles*™: One 1A, three 5A, two 10A, one 25A, one 40A. Switch. Voltmeter. 9W x 1 1/4H x 2 3/4D".

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Boost battery voltage as low as 9 Volts back up to 13.8 VDC! Keeps your transceiver at full power output, compensates for run down battery, wiring voltage drop, car off...

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$199.95

Keeps your transceiver at full power output, provides full performance, high efficiency, prevents output signal distortion and transceiver shutdown. Compensates for run-down battery, wiring voltage drop or when car is off. Provides up to 25 Amps peak with 90% efficiency. Selectable 9/10/11 Volts minimum input voltage prevents battery damage from over-discharging. RF sense turns MFJ-4416C off during receive to save power, increases efficiency and reduces noise. Adjustable 12 to 13.8 VDC output pass-through improves efficiency and lets transceiver run cooler. Has output over-voltage crowbar protection. *Anderson PowerPoles®* and high-current 5-way binding posts for DC input, regulated output. 7 3/4W x 4H x 2 1/8D inches. **MFJ-4416BRC, $84.95.** Booster Remote Control.

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RFI Filter for DC power

MFJ-1142
$74.95

Connects between rig and 12/24/50 VDC power supply/battery. Reduces RFI, hash, transients, motor noises, alternators, fuel pump whine, power windows, more! Binding posts/*PowerPoles®*.

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$14.95

Suppress RFI. Snap and locks on DC power line, coax, wires. Effectively removes RFI and noise. Install end-to-end or loop multiple turns for more suppression. .275" hole dia. 4 in package.

PowerPole™ DC Outlet Box

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One fused 30 Amp input and 25, 10, 5 Amp fused outputs with *Anderson PowerPoles®*. Has open fuse indicator. Sturdy metal construction, 2 3/4W x 3 1/4H x 1 1/2D inches.

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World's most compact 30 Amp switching power supply. Switchable Volt/Amp meter. Adjustable 4 to 16 VDC output. Select 120/240 VAC input. 5W x 2 1/2H x 6D in., 3 lbs.

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Instantly turn any wire into a small, high-efficiency multi-band transmitting loop antenna. Full 150W, 5.3-30 MHz.

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MFJ Field Strength Meter

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Relative field-strength readings .1-500 MHz. Sensitivity control, 1 3/4 inch meter. 20-inch telescoping whip. Finger contact increases sensitivity.

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Rival outside wire antennas hundreds of feet long and pick up signals loud and clear from all over the world. 0.3-40 MHz.

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Receives 25-1300 MHz. Transmits 50-1300 MHz up to 200 Watts.Test various Xmitters on one coax. 50 ft. coax, stainless steel elements.

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MFJ 2-Position Remote Antenna Switch

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MFJ 2-position *remote* antenna switch uses a *single* coaxial feedline to feed two antennas, DC power and control signals. Remotely switch HF and/or VHF antennas. Covers 1.8 MHz to 150 MHz and handles 1500 Watts. Impedance is 50-75 Ohms. Compact 4W x 2 5/8H x 1 1/2D". *Outside Switch Box* is fully enclosed and weather protected. Three quality *Teflon®* SO-239 connectors for transmitter, antenna one and antenna two. Stainless steel 1 1/2" tall bracket with a U-bolt for masts up to 1 1/2 in. O.D. *Inside biastee* control is 2 1/4W x 2 1/2H x 1 1/4 in. Use 12 VDC or 110 VAC with **MFJ-1312D, $19.95.**

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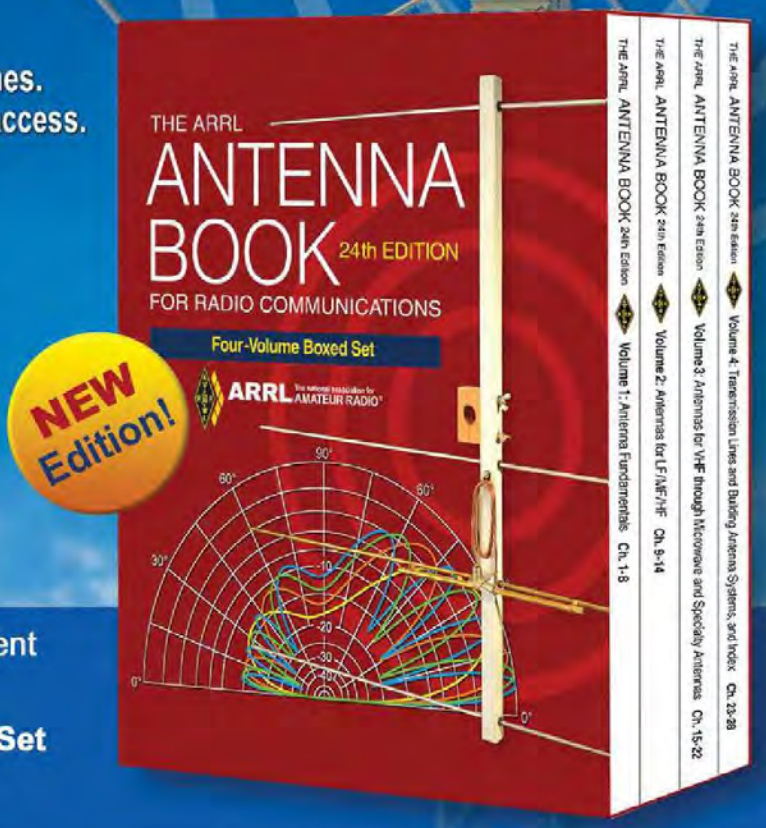

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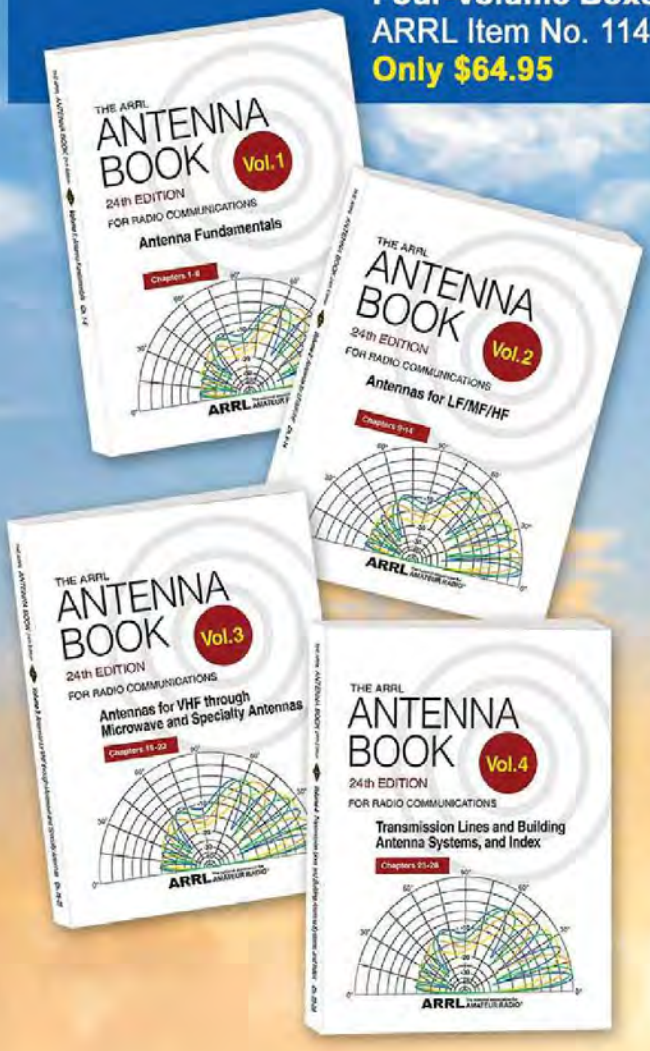

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MFJ 4-Band Octopus Antenna

Choose any 4 bands: HF/VHF/UHF

Octopus antenna hub turns your hamsticks into four fully balanced dipoles in minutes!

Mix and match any four HF/VHF/UHF bands.

Example: screw-in 80, 40, 20 Meter hamsticks and a dual band 2M/440 MHz whip (two on each band) on opposite sides. Now you have an automatic bandswitching 5-band dipole! Rotate it for maximum signal and minimum QRM and noise with a small rotator like **Hy-Gain AR-500, $169.95**.

Works at any height, low for local NVIS and high for DX. At a fixed height, (say 20-30 feet) use 80-Meters for NVIS and 20-Meters for low-angle DX.

Mounts on any mast up to 1-inch diameter. Use a fiberglass pole on a tripod and you're on the air!

Perfect for casual portable operation, limited space, HOAs, field day, camping, ARES during disasters.

Single coax feed, built-in balun.

Interaction between bands is minimized because the ends are spaced apart at a large angle.

You don't need an antenna tuner if you carefully tune each dipole. An easier way is to just set each dipole approximately on frequency and use an antenna tuner to operate and widen the bandwidth.

Hamsticks break down to about four feet for easy storage.

Tough Octopus Hub

Eight 3/8 x 24 threaded connectors for hamsticks. Super strong fiberglass filled ABS base insulator. Your Octopus hub will give you years of trouble-free service!
Based on Geoff Haines, N1GY, award-winning *December 2007 QST* article.

Super Octopus Deals

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MFJ-2104H, $559.95 Octopus hub with 75/40/20/15 Meter 600 Watt hamsticks. Saves $20!
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Mfj-2104HX, $569.95. Octopus hub with your choice of four (2 each) 600W hamsticks. Saves $20!

MFJ 250W & 600W *HamSticks*

MFJ *HamSticks* are ruggedly constructed. They have a sleek, low profile construction with low wind loading. Semi-rigid fiberglass eliminates the need for springs or guys while mobile.

Black anti-static jacket protects loading coil and blends with any vehicle. Nearly indestructible 4 foot, 0.125 inch diameter PH-17-7 stainless steel whips are adjustable for lowest SWR. Chrome plated brass fittings will give you years of reliable service.

Screws into any 3/8 x 24 female mount.

Includes allen wrench, tuning/matching instructions.

MFJ-16XXT *HamSticks* handle 250 Watts PEP. About 7 feet fully extended, 4 feet collapsed.

MFJ-26XXT *Hi-Q HamSticks* handle 600 Watts PEP. Much larger diameter loading coil and wire gauge gives you *higher-Q*. Lower losses let you dramatically talk further and hear better. 101 inches fully extended, 53 inches collapsed.

Band	600W	Price	250W	Price
75-M	MFJ-2675T	$69.95	MFJ-1675T	$29.95
60-M	N/A	N/A	MFJ-1660T	$29.95
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30-M	N/A	N/A	MFJ-1630T	$21.95
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17-M	MFJ-2617T	$49.95	MFJ-1617T	$19.95
15-M	MFJ-2615T	$49.95	MFJ-1615T	$19.95
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10-M	MFJ-2610T	$49.95	MFJ-1610T	$19.95
6-M	N/A	N/A	MFJ-1606T	$17.95
2M/440MHz	N/A	N/A	MFJ-1414	$24.95

AR-500 $169.95 Antenna Rotator

Rotate your Octopus dipoles for maximum gain and minimum QRM/noise!

Weatherproof one piece cast aluminum housing with precision all metal gears, steel thrust bearings and automatic braking. Includes rotator, controller, remote control, clamps, hardware. Remembers up to 12 directions!

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110/220VAC switchable.

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Super easy-to-use!

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World famous MFJ-259D gives you a complete picture of your antenna's SWR and Complex Impedance.

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You can read Complex Impedance as series resistance and reactance (R+jX) or as magnitude (Z) and phase (degrees).

Determine velocity factor, coax cable loss in dB, length of coax and distance to short/open.

You can read SWR, return loss and reflection coefficient at any frequency simultaneously.

MFJ No Matter What™ Warranty

Every MFJ Analyzer is protected by MFJ's famous one year **No Matter What**™ limited warranty. We will repair or replace your MFJ analyzer (at our option) for a full year.

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More hams use MFJ analyzers than all others in the world!

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280 KHz - 230 MHz *plus* 415-470 MHz, 280-230 MHz plus 2200Meters!

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MFJ-269D is a *super* MFJ-259D that adds 415-470 MHz and 12-bit A/D converter that gives you much better accuracy. *Complex Impedance Analyzer* reads series/*parallel* equivalents and magnitude/phase *CoaxCalculator*™ gives line length from electrical degrees and vice-versa for any frequency, Velocity Factor, coax loss in dB. Use any characteristic impedance 10-600 Ohms. Has LCD log SWR bargraph, N-connector.

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1-60 MHz Color Graphic VNA Analyzer

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- **DDS generator** precision signal source
- **Vivid 1600-pixel/inch** color graphics on a 2x2 inch non-glare TFT screen

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1.5-180 MHz *continuous* Two-Port Graphic Analyzer

Out in the field, MFJ-225 is a compact completely *self-contained handheld graphing analyzer*. On the bench it becomes a full-fledged two-port (S21) desktop machine when teamed up with your PC. Using powerful IG-miniVNA freeware, you'll run detailed data analysis and print out stunning color-graphic plots to document your work!

MFJ-225
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Built-in back-lighted *3-inch LCD graphic* display. Make fine adjustments using fullscreen easy-to-view SWR bargraph, capture vivid swept displays for SWR, impedance, return loss, phase angle, more. DDS generator.

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MFJ-269DPro, $459.95

Like MFJ-269D, but UHF range covers ***430 to 520 MHz*** to include commercial and industrial frequencies. Rugged protective shell protects knobs, switches, meters, digital display for commercial, industrial and lab work.

MFJ VNA Antenna Analyzer

MFJ VNA Antenna Analyzer covers 1 to 230 MHz, 1Hz resolution.

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- ***Sign of reactance*** positively identifies inductive or capacitive reactance
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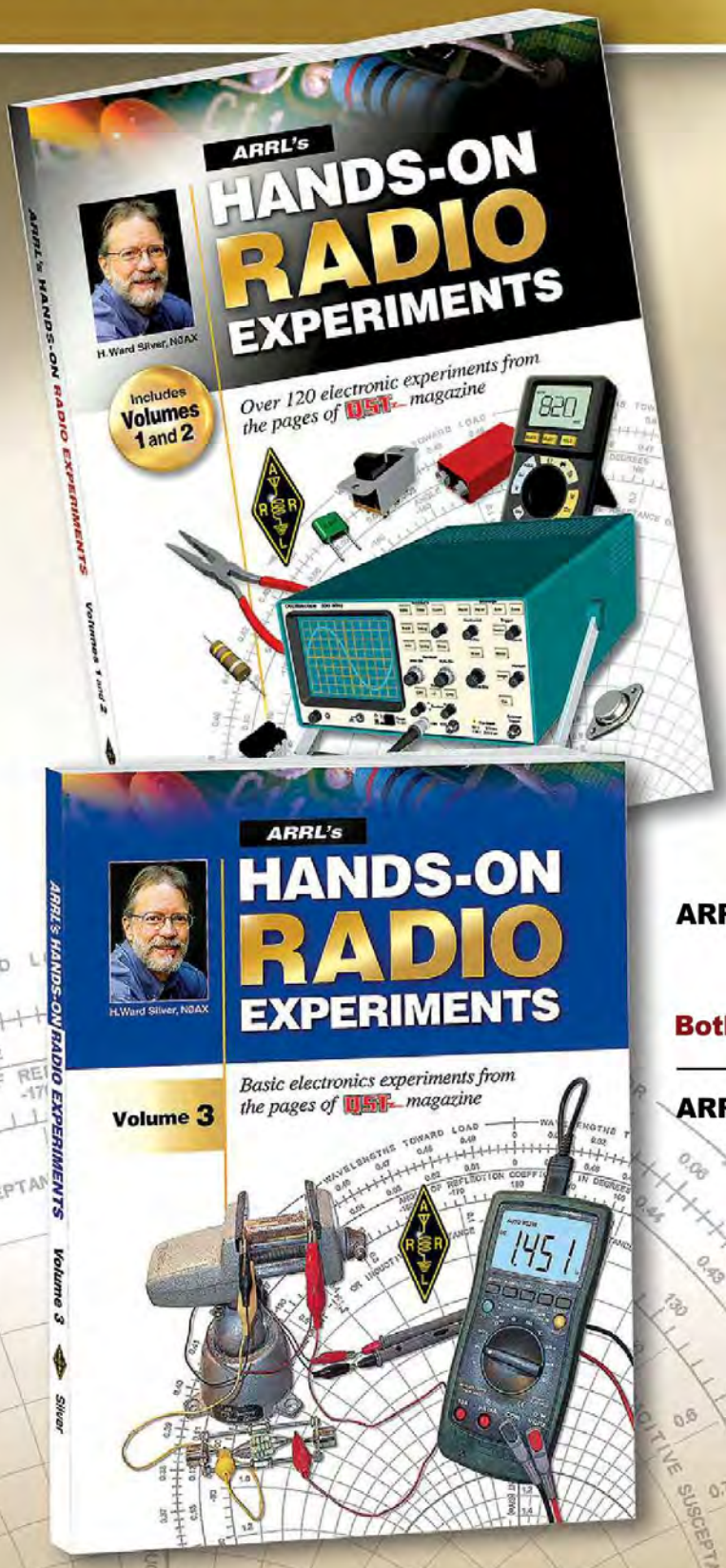

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Why? Because the world's leading tuner has earned a worldwide reputation for being able to match just about anything.

Full 1.8-30 MHz Operation

Tune your antenna for minimum SWR! Works 1.8-30 MHz on dipoles, verticals, inverted vees, random wires, beams, mobile whips, shortwave receiving antennas...Use coax, random wire, balanced lines. Has heavy-duty 4:1 balun for balanced lines.

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Custom designed inductor switch, 1000 volt tuning capacitors, Teflon® insulating washers and proper L/C ratio gives you arc-free no worries operation up to 300 Watts PEP transceiver input power.

The MFJ-949E inductor switch was custom designed to withstand the extremely high RF voltages and currents that are developed in your tuner.

8-Position Antenna switch

Antenna switch lets you select two coax fed antennas, random wire/balanced line or dummy load through your MFJ-949E or direct to your transceiver.

Lighted Cross-Needle Meter

Full size 3-inch lighted Cross-Needle Meter. Lets you easily read SWR, peak or average forward and reflected power simultaneously. Has 300 Watt or 30 Watt ranges.

QRM-Free PreTune™

MFJ's QRM-Free PreTune™ lets you pre-tune your MFJ-949E off-the-air into its built-in dummy load! Makes tuning your actual antenna faster and easier.

Plus Much More!

Full size built-in non-inductive 50 Ohm dummy load, scratch-proof Lexan multi-colored front panel, $10^5/_8$ x $3^1/_2$ x 7 inches. Superior cabinet construction and more!

MFJ-948, $189.95. Econo version MFJ-949E. Has all features except for dummy load.

No Matter What™ Warranty

Every MFJ tuner is protected by MFJ's famous one year **No Matter What™** limited warranty. We will repair or replace your MFJ tuner (at our option) for a full year.

More hams use MFJ tuners than all other tuners in the world!

MFJ-989D Legal Limit Tuner

MFJ-989D $469.95

New, improved MFJ- 989D legal limit antenna tuner gives you better efficiency, lower losses and a new true peak reading meter. Easily handles full 1500 Watts SSB/CW, 1.8-30 MHz, including MARS/WARC bands. Six position antenna switch, dummy load. New 500 pF air variable capacitors. New improved AirCore™ Roller Inductor. New high voltage current balun. New crank knob. $12^7/_8$W x 6H x $11^5/_8$D inches.

MFJ-986 Two knob Differential-T™

MFJ-986 $419.95

Two knob tuning (differential capacitor and AirCore™ roller inductor) makes tuning foolproof and easier than ever. Gives minimum SWR at only one setting. Handles 3 KW PEP SSB amplifier input power (1.5 KW output). Gear-driven turns counter, lighted peak/average Cross- Needle SWR/Wattmeter, antenna switch, balun. 1.8 to 30 MHz. $10^3/_4$W x $4^1/_2$H x 15 in.

MFJ-962D Compact kW Tuner

MFJ-962D $359.95

A few more dollars steps you up to a KW tuner for an amp later. Handles 1.5 KW PEP SSB amplifier input power (800W output). Ideal for Ameritron's AL-811H! AirCore™ roller inductor, gear-driven turns counter, pk/avg lighted Cross-Needle SWR/Wattmeter, antenna switch, balun, Lexan front, 1.8-30MHz. $10^3/_4$ x $4^1/_2$ x $10^7/_8$ in.

MFJ-969 300W Roller Inductor Tuner

Superb, AirCore™ Roller Inductor tuning. Covers 6 Meters thru 160 Meters! 300 Watts PEP SSB. Active true peak reading lighted Cross-Needle SWR Wattmeter, QRM-Free PreTune™, antenna switch, dummy load, 4:1 balun, Lexan front panel. $10^1/_2$W x $3^1/_2$H x $9^1/_2$D inches.

MFJ-969 $259.95

MFJ-941E Super Value Tuner

Most for your money! 300 Watts PEP, 1.8-30 MHZ, lighted Cross-Needle SWR/Wattmeter, 8 position antenna switch, 4:1 balun, 1000 volt capacitors, Lexan front panel. $10^1/_2$W x $2^1/_2$H x 7D in.

MFJ-941E $169.95

MFJ-941EK, $149.95. Tuner Kit -- Build your own!

MFJ-945E HF/6M Mobile Tuner

Extends your mobile antenna bandwidth so you don't have to stop, go outside and adjust your antenna. Tiny 8 x 2 x 6 in. Lighted Cross-Needle SWR/Wattmeter. Lamp and bypass switches. Covers 1.8-30 MHz and 6 Meters. 300 Watts PEP. **MFJ-20, $9.95**, mobile mount.

MFJ-945E $159.95

MFJ-971 Portable/QRP Tuner

Tunes coax, balanced lines, random wire 1.8-30 MHz. Cross-Needle Meter. SWR, 30/300 or 6 Watt QRP ranges. Matches popular MFJ transceivers. Tiny 6 x $6^1/_2$ x $2^1/_2$ in.

MFJ-971 $149.95

MFJ-901B Smallest Versa Tuner

MFJ's smallest (5 x 2 x 6 in.) and most affordable wide range 200 Watt PEP Versa tuner. Covers 1.8 to 30 MHz. Great for matching solid state rigs to linear amps.

MFJ-901B $119.95

MFJ-902B Tiny Travel Tuner

Tiny $4^1/_2$ x $2^1/_4$ x 3 inches, full 150 Watts, 80-6 Meters, has tuner bypass switch, for coax/random wire. **MFJ-904H, $169.95**. Same but adds Cross-needle SWR/Wattmeter and 4:1 balun for balanced lines. $7^1/_4$ x $2^1/_4$ x $2^3/_4$ inches.

MFJ-902B $129.95

MFJ-16010 Random Wire Tuner

Operate all bands anywhere with MFJ's reversible L-network. Turns random wire into powerful transmitting antenna. 1.8-30 MHz. 200 Watts PEP. Tiny 2 x 3 x 4 in.

MFJ-16010 $79.95

MFJ-9201 QRPocket™ Tuner

80-10 Meters, 25 Watts. 12 position inductor, tune/bypass switch, wide-range T-network, BNCs. 4W x $2^5/_8$H x $1^1/_2$D inches. **MFJ-9201, $59.95**

MFJ-9201 $59.95

MFJ-921/924 VHF/UHF Tuners

MFJ-921 covers 2 Meters/220 MHz. **MFJ-924** covers 440 MHz. SWR/Wattmeter. 8 x $2^1/_2$ x 3 in.

MFJ-921/924 $109.95

MFJ-931 Artificial RF Ground

Eliminates RF hot spots, RF feedback, TVI/RFI, weak signals caused by poor RF grounding. Creates artificial RF ground or electrically places far away RF ground directly at rig. **MFJ-934, $249.95**, Artificial ground/300 Watt Tuner/Cross-Needle SWR/Wattmeter.

MFJ-931 $129.95

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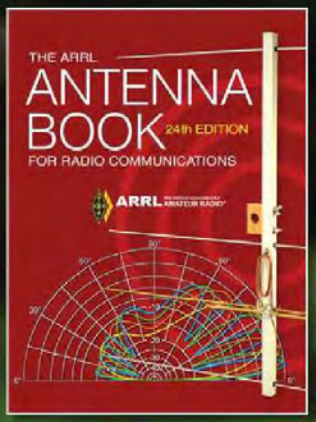

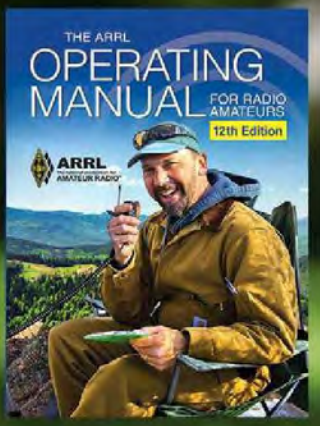

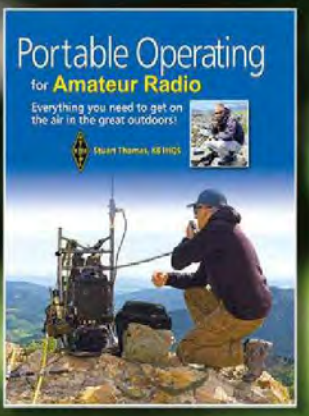

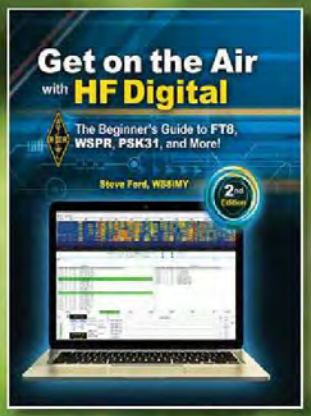

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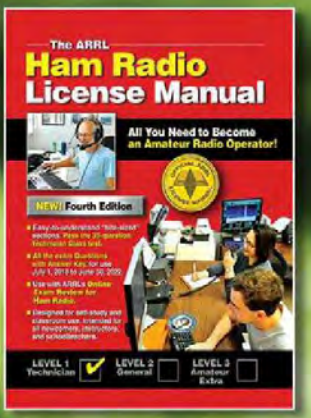

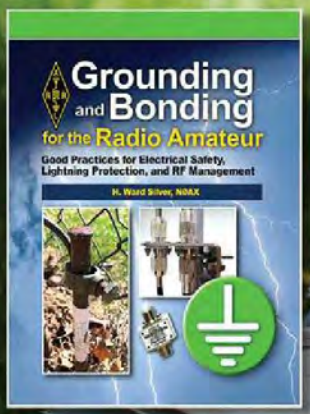

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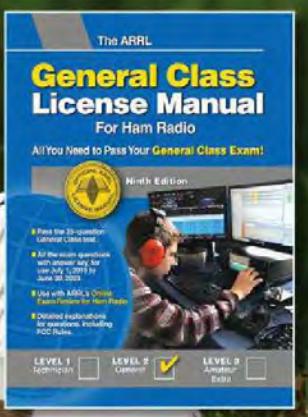

MFJ Dummy Loads & SWR/Wattmeters

Dummy Loads

World's most popular Dry 300 Watt HF/VHF Dummy Load

Air-cooled, non-inductive resistor in a perforated metal housing; Has SO-239 connector. Full 300W for 30 seconds. Derating curve to 5 minutes. SWR below 1.1:1 to 30 MHz, 1.5:1 30 to 650 MHz. Compact 2¼ x 2¼ x 7 inches. **MFJ-260CN, $59.95.** With type "N" connector.

MFJ-260C $49.95

Dry 1.5 kW HF/VHF/UHF Dummy Load

Ham radio's most versatile 1.5 kW 50 ohm *dry* dummy load covers DC through 650 MHz. SWR 1.1:1 to 30 MHz and 1.3:1 to 650 MHz. Handles 1500 Watts for ten seconds, 100 Watts for 10 minutes. 3W x 3H x 9D in. SO-239 connector. **MFJ-264N, $109.95.** With type "N" connector.

MFJ-264 $89.95

Oil-Cooled 1 kW CW, 2 kW SSB 50-Ohm VersaLoad™

Run 1kW CW or 2 kW PEP for 10 minutes. Run *continuous duty* with 200 Watts CW or 400W PEP. Transformer oil included. SWR 1.2:1 to 30 MHz. Low SWR to 400 MHz. SO-239 connector. Safety vent with cap, carrying handle. 7½H x 6⅝D in. **MFJ-250X, $69.95.** No transformer oil.

MFJ-250 $79.95

500 MHz, 100 Watt Dummy Load

Connects directly with built-in PL-259. Finned aluminum air-cooled heatsink. 15 Watts continuous, 100W peak. SWR <1.5:1, DC-500 MHz. 15/8 inch round by 3 inches long. **MFJ-262B, $69.95.** PL-259. 35 Watts continuous, 200W for 5-seconds. SWR< 1.2;1 DC-1 GHz.

MFJ-261 $34.95 *with PL-259* DC to 500 MHz

MFJ 2500W *fan-cooled* Dry Load

MFJ's 2500 Watt *fan cooled* load handles legal limit amps, 2500W average one minute on, ten minutes off, 300W continuous. DC- 6 Meters. SWR <1.25, 30 MHz; <1.4, 30-60 MHz. Detailed power curve. 12 VDC or 110 VAC. 8¼W x 4H x 9½D in. SO-239s. 5 pounds.

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Select 16.6, 25, 50, 100, 150 Ohm dummy loads. Test/calibrate your wattmeters, SWR accuracy. At 50 Ohms it handles 300 Watts for 30 seconds with SWR < 1.1, 60 MHz. SO-239. 4½W x 2¼H x 6½D in. Optional 12 VDC/110 VAC adaptor, **MFJ-1312D, $19.95**.

MFJ-251 $169.95

3 GHz, 300 Watts Dry Dummy Load

New high-tech metal film resistor on large heavy-duty air-cooled heatsink. 300 Watts for ten seconds and 125W continuously. SWR < 1.1, 1 GHz; <1.2, 1.5 GHz; <1.5, 3 GHz. N-connector. 10¾W x 2¼H x 5¼D inches.

MFJ-263 $139.95

1.5kW Dry DummyLoad/SWR/Wattmeter

Tune up your transceiver, linear amplifier or antenna tuner into a safe 50 Ohm dummy load at *full power*. Then instantly switch to your antenna and monitor SWR, forward and reflected power on lighted cross-needle meter. 300/3000 Watt ranges. DC-60 MHz.Test/tune Xceivers, amps, tuners, baluns, filters, coax, stubs.

MFJ-267 $179.95

SWR/Wattmeters

Compact Cross-Needle SWR/Wattmeters

Large 3-inch lighted Cross-Needle meter covers 1.8-200 MHz in 30/300W power ranges. Read forward, reflected power, SWR *simultaneously*. 3¼W x 3¼H x 3¼D in. SO-239 connectors. **MFJ-842, $69.95.** 140-525 MHz, 15/150W.

MFJ-822 $69.95

High-accuracy 1.8-60 MHz Digital SWR/Wattmeter

Highly accurate! Auto-ranging select 25W, 250W, 1500W ranges with *full 10-bit* resolution. Frequency compensated data insures highest accuracy. *True peak*/average forward/reflected power, SWR and frequency are *simultaneously* displayed on backlit LCD and large 3-inch lighted cross needle meter. Peak hold. LED, buzzer, amplifier-by-pass alerts and protects your amplifier when SWR is high and toggles extra relay. 6½W x 2⅝H x 6D". **MFJ-826B, $199.95.** No meter, ampr bypass, control relay.

MFJ-828 $269.95

MFJ GrandMaster™ SWR/Wattmeters

GrandMaster™ SWR/Power Meters are the *Cadillacs of ham radio!* Large 3¼ x 1¼ inch precision illuminated meter gives easy wide-angle viewing of SWR, forward or reflected power. 7½W x 3⅛H x 4¼D in. SO-239s. **MFJ-870, $89.95.** 1.6-60 MHz. 30/300/3000 Watt ranges. **MFJ-874, $129.95.** 1.8-525 MHz. 5/20/200 Watt ranges.

MFJ-870 $89.95

MFJ *giant* 6.5 inch SWR/Wattmeter

World's *largest* HF+6M SWR/Wattmeter has giant 6½ inch meter! Extra-long scales gives highly accurate SWR/power 1.8-54 MHz. Huge numbers make reading easy. *True* peak or average forward and reflected power. 20/200/2000 Watt ranges. 9 Volt battery, 12 VDC or 110 VAC with **MFJ-1312D, $19.95.** 7W x 5½H x 5D in. SO-239s.

MFJ-868B $179.95

VHF SWR/Wattmeter plus Field Strength

World's most popular – and most affordable – VHF SWR/Wattmeter. Read SWR, forward and reflected power over 144-220 MHz in two ranges, 30/300W. Built-in field strength meter for 1-220 MHz. 4½W x 2¼H x 3D".

MFJ-812B $49.95

Compact Digital SWR/Wattmeters

Displays forward, refelected power, SWR (1.6-60 MHz) and battery *all in a single glance!* Large ½" forward power digits and 5/8" reflected/SWR digits! 0-200W. Power/backlight on/off. SO-239s. **MFJ-847, $114.95.** 125-525 MHz, 0-120W. **MFJ-849, $189.95.** Large 3.5" bright orange LCD displays SWR, forward/reflected power. 1.5-525 MHz, 200W, HF/VHF-UHF switch.

MFJ-845 $114.95

MFJ-849 $189.95

MFJ HF *QRP* SWR/Wattmeter

Read forward, reflected power 1.8- 50 MHz, 0-5W. Also reads SWR, relative power 100 mW to 50W. SO-239s. 4½W x 2¼ H x 3D in.

MFJ-813 $49.95

VHF/UHF SWR/Wattmeter

Lighted Cross-Needle,SWR/Watts,144/220/440 MHz, 30/300W Forward power, 6/60W Reflected power.

MFJ-862 $79.95

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MFJ ANTENNAS

MFJ Wire Antennas

G5RV -- *Most popular antenna in the world!*

Operate 80-10 or 40-10M with tuner. 14 gauge, 7-strand copper antenna wire. 1.5kW. 32.5' ladder line matching section with SO-239 for coax.
MFJ-1778, $69.95. 80-10M. 102 feet long.
MFJ-1778M, $59.95. 40-10M. 52 feet long.

End Fed Half Waves

Operate 80-10 or 40-10M with one support/no tuner.
80-10 Meters, 132 feet:
MFJ-1982HP, $109.95. 800 Watts.
MFJ-1982MP, $79.95. 300 Watts.
MFJ-1982LP, $59.95. 30 Watts.
40-10 Meters, 66 feet:
MFJ-1984HP, $89.95. 800 Watts.
MFJ-1984MP, $69.95. 300 Watts.
MFJ-1984LP, $49.95. 30 Watts.

Off Center Fed Dipoles

Lightweight, virtually invisible. Gives you directivity and gain (*see MFJ website*).
MFJ-2012, $89.95, 40/20/10/6 Meters, 1500 Watts. 67 ft.
MFJ-2010, $69.95. 40/20/10/6 Meters, 300 Watts. 67 ft.
MFJ-2014, $119.95. 75/40 Meters, 1500 Watts. 122 ft.
MFJ-2016, $149.95. 160/75/40 Meters, 1500 Watts. 240 ft.
MFJ-2013, $89.95. 60/30 Meters, 300 Watts. 86 ft.

Dual Band 80/40 or 40/20 Dipoles, 1.5 kW

MFJ-17758, $109.95. 80/40 Meters, 95 feet long, ultra-efficient end-loading on 80 Meters. No tuner needed. Super-strong center insulator, built-in SO239, hanghole.
MFJ-17754, $69.95. 40/20M, 42 ft.

MFJ All Band Doublet

MFJ-1777, $79.95.102 foot, 160-6 Meters with tuner/balun. *Extremely low feedline loss.* Super strong fiberglass center insulator provides stress relief for included 100 feet ladder line. *Ceramic* end insulators. 1500 Watts SSB/CW/Digital.

MFJ 1.5 kW Dipoles

7-strand, 14-ga. copper wire.*Ceramic* insulators. Center insulator with SO-239
MFJ-1779C, $39.95. 20-6M, 35 feet.
MFJ-1779B, $59.95. 80-40M,135 feet.
MFJ-1779A, $79.95. 160M, 265 feet.

20M Extended Double Zepp

MFJ-1742, $99.95. See web for gain. 90 ft. long, 100 ft. ladder line. 7-strand, 14-ga. wire. 80-10M with tuner/balun. 1500 Watts SSB/CW/Digital.

80M End-Fed Zepp

MFJ-1748, $99.95. 125 feet long, 100 foot ladder line included. 7-strand, 14-ga. wire. Use tuner/balun. 1500 Watts SSB/CW/Digital.

MFJ Vertical Mounted Antennas

MFJ 6-Band Cobweb Antenna

MFJ-1836H, $299.95. Six-bands: 20/17/15/12/10/6 Meters, 1.5 kW. *Perfect for restricted space*. Nearly invisible. 9x9x½ feet, 8 lbs. Outstand-ing performance! Horizontally polarized gives less noise, more gain over verticals. Omni-directional. No radials needed! Works great at low heights. Low SWR.
MFJ-1836, $269.95. Like MFJ-1836H, but 300 Watts.

MFJ *4-Band* Dipole Octopus Antenna

***Octopus** antenna hub turns hamsticks into four balanced* HF/VHF/UHF *dipoles!* Rotate for maximum signal, minimum QRM/noise. Mount low for local NVIS, high for DX. Perfect for portable, limited space, HOAs, camping, ARES. Balun. No tuner needed.
MFJ-2104, $289.95. Includes 8 hamsticks for 75/40/20/15 M.
MFJ-2100, $119.95. Hub only. Use eight hamsticks.

MFJ Multi-Band Verticals, no radials needed!

Low angle radiation lets you easily work far-away, rare DX!
Efficient end loading gives maximum radiated power.
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Low profiles blend into any surroundings. Mount them anywhere ground level, roof tops, apartments, houses, small lots.
Efficient high-Q coils. High power air-wound choke balun.
Built-to-last. Solid fiberglass rod, aircraft aluminum tubing.
5 models: Choose your bands 80-2 Meters
MFJ-1796, $339.95. 6 bands: 40/20/15/10/6/2M, 12 feet.
MFJ-1797, $369.95. 7 bands:40/30/20/17/15/12/10M. 23 ft.
MFJ-1797LP, $339.95. Like MFJ-1797, but only 9 feet tall. Narrower bandwidth on 40 Meters.
MFJ-1799, $449.95.10 bands: 80/40/30/20/17/15/12/10/6/2M. 20 ft.
MFJ-1799X, $399.95. Like MFJ-1799, but less 80M.

MFJ 43-foot Vertical, 160-6 Meter

MFJ-2990,$399.95. High performance 43 foot vertical operates 160-6 Meters, 1500 Watts SSB/CW/Digital. 2 square feet wind load. Self-supporting, no guy wires needed. 6063 aircraft aluminum tubing, bottom section 2" OD, .120" wall thickness. 20 lbs. Requires antenna tuner, ground/counterpoise.

BigStick ™ Vertical

MFJ-2286, $119.95. 7-55 MHz, *full 1/4 wave* 20-6M, 40M coil. 17 ft. extended, 28" collapsed. 2 lbs. 1 KW. Mount, radial kit included.

BigEAR ™ Dipole

MFJ-2289, $209.95. 7-55 MHz. *Full-size* 20-6 Meter dipole, 40M air loading coil. Two 17 ft. telescopic whips, 28" collapsed.

MFJ-915, $39.95 RFI Isolator

Prevents unwanted RF from traveling on your coax shield into your expensive transceiver. Prevents painful RF "bites" and erratic operation. 1.5 kW. 1.8-30 MHz.

MFJ-918, $39.95 4:1 Balun

True 1:1 current balun/center insulator. High-permeability ferrite beads on RG-303 *Teflon*(R) coax. 2" dia.x6" long. 14 gauge 7-strand copper wire. 1.5 kW 1.8-30 MHz.

MFJ-913, $39.95, 300W
MFJ-919, $69.95, 1.5 kW

True 4:1 current baluns/antenna center insulators transform 200 ohms to 50 ohms, 1.8-30 MHz. Transmission line transformer, low permeability ferrite cores, SO-239, stainless steel hardware with direct 14 gauge stranded copper wire to antenna.

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MFJ-270, $24.95. 400W.
MFJ-272, $39.95. 1500W. Gas discharge tube shunts 5000 amps peak.< 0.1 dB loss. 1 GHz. SO-239s.

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MFJ-1702C, $49.95. 2-position antenna switch, lightning surge protection, center ground.

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In January 2020, we launched our newest member benefit—*On the Air* magazine aimed at helping newly licensed and beginner-to-intermediate hams navigate the world of amateur radio.

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- How to select the best equipment for your interest and experience
- Tips for setting up your station & building projects
- Ways to get involved with emergency communications
- Experiences and stories of others who are getting started in amateur radio

All ARRL members will receive the digital versions of both *QST* and *On the Air*. Eligible U.S. members will be able to select one of these publications to be delivered in print.

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ABR Industries now offers factory installed ferrites as an option on ABR100 (.100") to ABR600 (.590"). All cables are 100% tested and available for immediate shipment. Cores range from 1 MHz to 1 GHz. Standard Connector options are UHF, N-Type, BNC, SMA, TNC, and Mini-UHF. Custom lengths, special connector types, and special cable types are available too.

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Ham Ads

Please contact the Advertising Department at 860-594-0255 or hamads@arrl.org for further information or to submit your ad.

For information on placing a Classified Ad:
www.arrl.org/ham-ads-classified-rules-and-rates

Before considering a ham ad please read.

1. Advertising must pertain to products and services which are related to Amateur Radio.

2. The Ham-Ad rate for commercial firms offering products or services for sale is $2.25 per word. Individuals selling or buying personal equipment: ARRL member 1.00 per word. Non-ARRL member $1.50 per word. **Bolding** is available for $2.50 a word. Prices subject to change without notice. You may pay by check payable to the ARRL and sent to: Ham-Ads, ARRL, 225 Main St., Newington, CT 06111. Or, you may pay by credit card sending the information by fax to 860-594-4285 or via e-mail to hamads@arrl.org. The credit card information we need is: the type of credit card, the exact name that appears on the credit card, the credit card number, the expiration date and the credit card billing address.

3. Remittance in full must accompany copy since Ham-Ads are not carried on our books. Each word, abbreviation, model number and group of numbers counts as one word. Entire telephone numbers count as one word. No charge for postal Zip code. No cash or contract discounts or agency commission will be allowed. Tear sheets or proofs of Ham-Ads cannot be supplied. Ads submitted in writing should be typed or printed clearly on an 8 1/2" X 11" sheet of paper.

4. Closing date for Ham-Ads is the 15th of the second month preceding publication date. No cancellations or changes will be accepted after this closing date. Example: Ads received December 16th through January 15th will appear in March *QST*. If the 15th falls on a weekend or holiday, the Ham-Ad deadline is the previous working day. Please contact the Advertising Department at 860-594-0255 or hamads@arrl.org for further information or to submit your ad.

5. No Ham-Ad may use more than 200 words. No advertiser may use more than three ads in one issue. Mention of lotteries, prize drawings, games of chance etc is not permitted in *QST* advertising.

6. New firms or individuals offering products or services for sale must check with us to determine if a production sample (which will be returned) should be submitted for examination. Dealers are exempted, unless the product is unknown to us. Check with us if you are in doubt. You must stand by and support all claims and specifications mentioned in your advertising.

The publisher of *QST* will vouch for the integrity of advertisers who are obviously commercial in character and for the grade or character of their products and services. Individual advertisers are not subject to scrutiny.

The American Radio Relay League does not discriminate in its advertising on the basis of race, color, religion, age, sex, sexual orientation, marital status or national origin. The League reserves the right to decline or discontinue advertising for any other reason.

7. AN IMPORTANT NOTICE TO ALL HAM AD POSTERS AND RESPONDERS, FROM THE ARRL ADVERTISING DEPARTMENT Greetings from ARRL HQ! Please note that we have received reports from many ARRL members who have placed classified ads in these listings, and have received responses from individuals proposing "creative" payment schemes. These particular instances involved offers of overpayments for goods by bank check, followed by instructions to deduct the cost of your item from the overpayment, and to transfer the overage back or to another individual. This is a well-known scam. Unfortunately, we have no control over this and other scams of this type. Once your email address is posted, you are vulnerable to those individuals seeking to provide you with questionable information.

QST Ham Ads on the Web
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